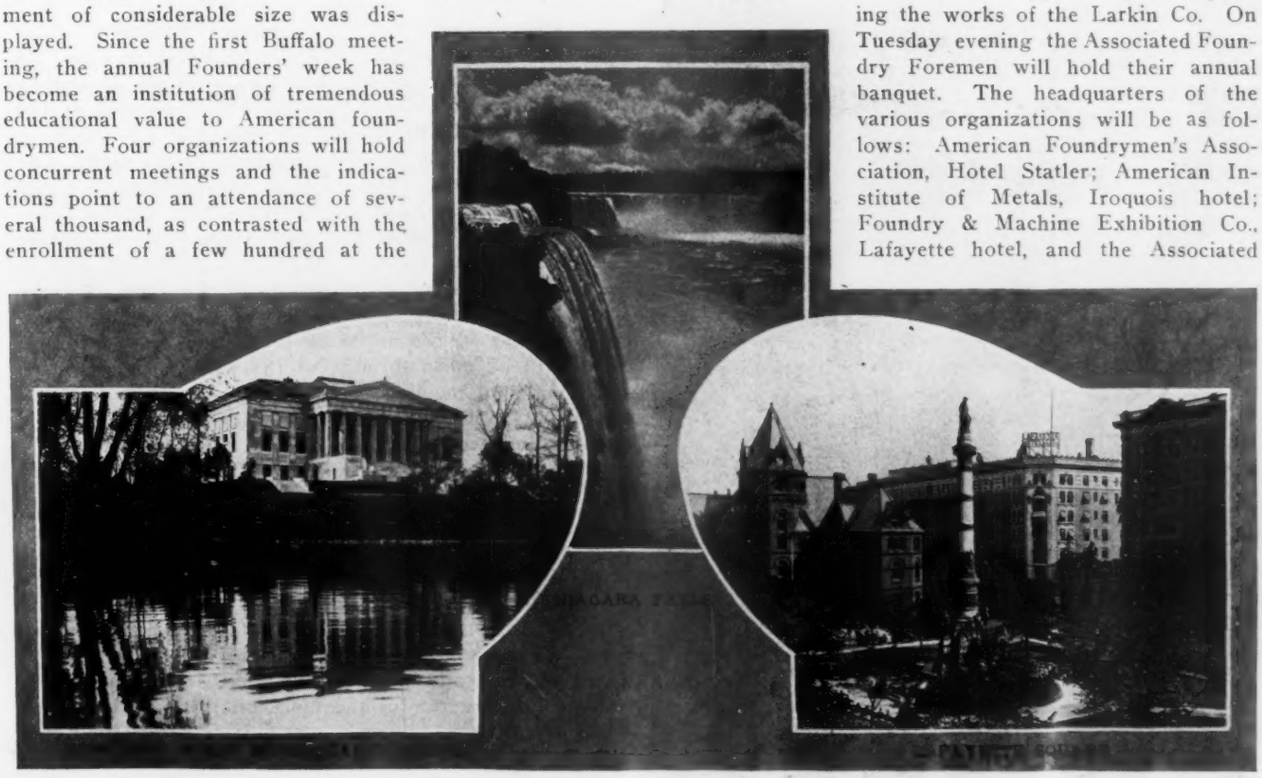
Vol. 40, No. 10 Cleveland, Ohio, October, 1912 Whole No. 242

Buffalo Heartily Welcomes Allied Foundrymen

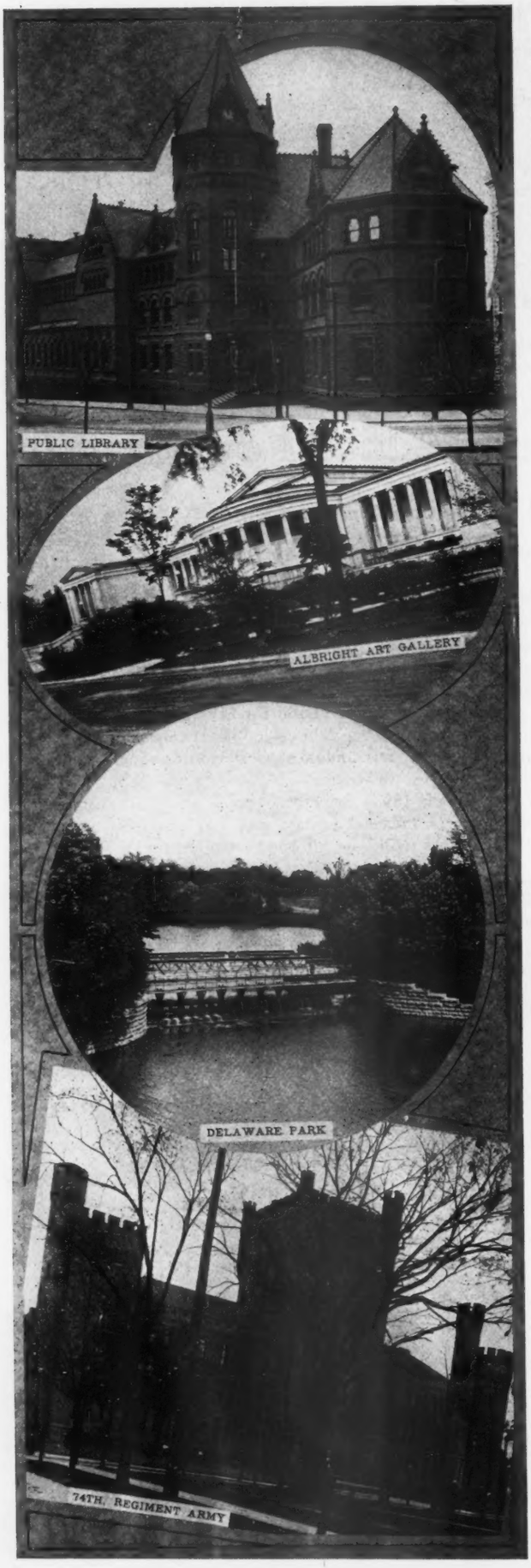
Program of the Conventions of the Various Associations, Entertainment Features and Exhibit of Foundry Equipment and Supplies

AFTER the elapse of practically a decade, Buffalo again will be the meeting place of the allied foundrymen's organizations, during the week of Sept. 23. The American Foundrymen's Association, at the time of the previous gathering, was still in its infancy and the foremen's society was still in a stage of formation. Several manufacturers made small exhibits at the various hotels, but these consisted largely of supplies and no equipment of considerable size was displayed. Since the first Buffalo meeting, the annual Founders' week has become an institution of tremendous educational value to American foundrymen. Four organizations will hold concurrent meetings and the indications point to an attendance of several thousand, as contrasted with the enrollment of a few hundred at the first Buffalo gathering. Three-day sessions will be held by the American Foundrymen's Association and the American Institute of Metals, while the Associated Foundry Foremen will meet to elect officers and will give its annual banquet. The exhibition of foundry supplies and equipment, at the Broadway Arsenal, promises to surpass all previous shows of this kind. Nearly 100 manufacturers have reserved space and the exhibits will cover approximately 47,000 square feet.

An elaborate entertainment program has been prepared by the foundrymen of Buffalo, which will provide ample diversion for the visitors, and includes a lake ride on Wednesday afternoon and a subscription banquet, Thursday evening. The ladies will visit the Roycroft shops at East Aurora on Tuesday, and on Thursday they will be afforded an opportunity of inspecting the works of the Larkin Co. On Tuesday evening the Associated Foundry Foremen will hold their annual banquet. The headquarters of the various organizations will be as follows: American Foundrymen's Association, Hotel Statler; American Institute of Metals, Iroquois hotel; Foundry & Machine Exhibition Co., Lafayette hotel, and the Associated



POINTS OF INTEREST AT BUFFALO AND IMMEDIATE VICINITY



Foundry Foremen, Broezel house. As a convention city, Buffalo affords many attractions. Aside from the wonderful industrial development of this district, there are many features of interest to visitors, and the proximity of Niagara Falls adds to the attractiveness of the city as a meeting place for various organizations. Among the leading foundry centers of the United States, Buffalo ranks ninth with 66 casting plants. Of these, 20 melt brass exclusively, and there are 41 gray iron shops, as well as several malleable and steel foundries. Of the 20 blast furnaces in this district, 11 are engaged in the manufacture of pig iron for the foundry trade.

For several months the foundrymen of Buffalo have been making preparations for the reception of their visitors. The general committee in charge of the arrangements consists of H. D. Miles, Buffalo Foundry & Machine Co., chairman; E. W. Sherman, vice chairman; W. H. Barr, Lumen Bearing Co., treasurer, and Geo. C. Lehmann, secretary. The other members of the committee are as follows: W. M. Corse, T. L. Richmond, W. F. Wendt, Willis N. Edwards, Walter F. Semon, F. W. Tracy, Robt. B. Thomson, Geo. V. Horgan, Harold J. Balliett, Frank B. Baird, J. P. Williams, J. M. Olmsted, P. J. Krantz, E. B. McKenna, J. W. Pohlman, D. W. Sowers and Geo. P. Warner.

Chairmen of the various other committees have been elected as follows: W. H. Barr, finance; W. F. Semon, reception and press; T. L. Richmond, printing; Frank B. Baird, entertainment, and H. W. Wendt, exhibits.

The foundrymen of Boston, New York, Philadelphia and Pittsburgh have chartered special cars for their trip to Buffalo, while the Chicago Foundrymen's Club and all foundrymen in the central west will leave in a body on a special train which leaves Chicago, via the Michigan Central railroad at 9 a. m., Sunday, Sept. 22, arriving at Detroit at 3:30 p. m. From Detroit the trip will be made by steamer, arriving in Buffalo at 9 a. m. Monday morning.

Professional Sessions

Professional sessions of the American Foundrymen's Association and the American Institute of Metals will be held on Tuesday, Wednesday and Thursday, Sept. 24, 25 and 26. The exhibition of foundry supplies and equipment at the Broadway Arsenal will be formally opened at 9 a. m., Monday morning, and will be continued until Friday night. The floor area of the exposition building exceeds that of either the Madison Square Garden, New York City, or the Coliseum, at Chicago. Aside from the columns which support two balconies, the floor is entirely unobstructed, and is unusually well adapted to exhibitions of this type. A large part of the equipment to be displayed will be operated and demonstrations of the utility of the various machines and devices will be made throughout the week. An unusually large number of molding machines will be shown and several exhibits will contain the latest devices intended for the rapid and economical handling of foundry materials.

Rogers, Brown & Co. in Moving Pictures

One of the interesting features of the exhibit will be a series of moving pictures displayed by Rogers, Brown & Co., pig iron merchants, Cincinnati. These are said to be the most complete of any yet made of any industrial operation. These pictures cover the entire cycle of iron ore mining, handling and shipping operations, the manufacture of pig iron and a few of the more interesting steel processes, and are spread over a range of territory from the mines at Hibbing, Minn., to the blast furnaces of Rogers, Brown & Co., at Buffalo. These pictures have been in process of taking for a period of nine months, the work

having been done by the Motionscope Co., under the personal supervision of H. B. B. Yergason, of Rogers, Brown & Co. During the past several years, Rogers, Brown & Co. have been increasing their holdings of iron ore properties on the Lake Superior ranges and, with their affiliated companies, are able to show practically the entire pig iron making process in connection with their own properties and interests.

These pictures include such scenes as the panoramic view of the great Mahoning mine at Hibbing, a descent into this mine, operation of shovels and the shipment of ore and similar views will be presented of the Susquehanna mine of the Rogers-Brown Iron Co., illustrating the method of stripping and the operation of the largest type of steam shovels. From this point is followed in detail the transportation of the ore to Duluth and the operations attending the handling and shipping from the great docks at that point. One of the views was made in an ore boat and shows an avalanche of ore pouring into the hold. Views of the great lake freighters on their way down the lakes to the furnaces, as well as views en route, both at the Soo and in the St. Clair river, also will be presented.

At the furnaces, every operation of handling the ore will be given in detail. These include stocking the ore and its distribution, charging the blast furnaces by the skip hoist, making pig molds and casting pig iron both by the sand and machine methods. The handling of pig iron by the electric magnet also will be displayed. Steel works' operations include the manufacture of Bessemer steel, charging and blowing a converter, casting into ingot molds, stripping, re-heating and rolling steel rails and sheet piling.

Subjects of Motion Pictures

A synopsis of the motion pictures follows:

Panoramic view of the Mahoning and Hull-Rust mines.

Trip through the Mahoning mine from a moving flat car. Among other views there is one of a heavily-loaded ore train leaving the mine and an interesting view from the lowest point of the mine, showing five working levels on which are shown steam shovels and trains.

Panoramic view of the Susquehanna mine, showing plainly the shovels that were at work both stripping and mining iron ore. This view also shows the great depth of the stripping before the ore bed was reached.

Drilling in iron ore for light blasting to loosen the ore for the steam shovel.

Arrival of a string of empty cars and a steam shovel at work loading ore at the Susquehanna mine.

Near view of a shovel at work in an ore bed.

Train of loaded cars leaving the mine, showing the heavy grade and its extreme depth.

Arrival of the ore train at the Mesabi dock, showing 50-ton cars and a large locomotive.

Train of 97 empty cars leaving the docks.

Panoramic view of coal and ore dock, showing a vessel unloading coal on one side and two of the largest types of ore boats loaded with ore at the other side. These pictures give a splendid idea of the size of these vessels, length of dock, dock construction and ore train coming out onto the dock.

Panoramic view of the Mesabi dock from the top of an ore car on top of the dock, showing the cars emptying ore into pockets.

Deck of an ore boat, showing the removal of the hatches preparatory to entering the dock before loading.

Mesabi docks from the water front, showing an ore boat entering the slip.

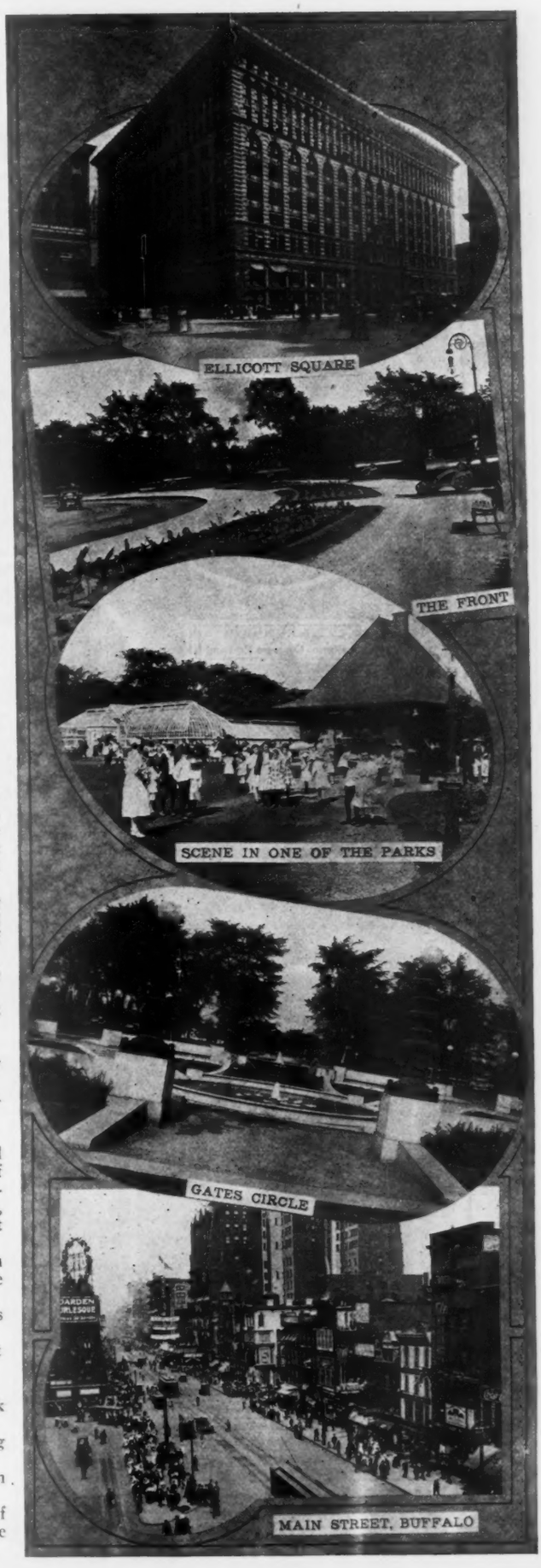
Poling ore from the dock pockets.

Lowering the chutes for discharging ore from the dock bins to the hold of the vessel.

In the hold of an ore boat, showing the iron ore flowing into the hold.

The fire boat McGonagle, maintained for the protection of the Masabi docks.

Boat pulling out from the dock, showing the closing of the hatches. This view was taken from the end of the dock looking down onto the vessel.



THE MEN BEHIND THE BUFFALO MEETING

T. L. RICHMOND
Chmn. Com. on Printing

W. F. SEMON
Chmn. Reception Com.

H. D. MILES
Chmn. Gen. Conv. Com.

WM H. BARR
Chmn. Finance Com.

HENRY W. WENDT
Chmn. Com. on Exhibits

Panoramic view of the ship canals at the Soo, showing the St. Mary's Rapids with the Canadian shore in the distance.

Lowering the water in the locks, the entering of an ore boat, closing the lock gates, filling the lock and the boat leaving on the higher water level.

Life boat drill on the steamer Agnew.

Passing loaded ore boats in the St. Clair river.

Pictures of attractive points in the St. Clair river.

Panoramic view of the Iroquois furnaces at Buffalo, as seen from an approaching ore boat.

Hewlett ore unloading machines operating outside of and in the hold of a vessel.

Panoramic view of the Susquehanna furnaces, taken from an approaching ore boat.

Ore bridges and buckets operating outside of and in the hold of an ore boat.

Transferring ore from the stock pile to a larry and distributing the ore into the bins from the larry.

Charging a blast furnace, showing the operation of the skip hoist with a close view of the furnace top and the discharge of the bucket's contents into the top.

Making the pig beds preparatory to running a cast.

Opening the slag notch of the blast furnace and running off the slag.

Pulverizing the slag in the slag pit.

Dumping the slag from ladle cars onto the slag pile.

Tapping the furnace, showing the operation of the electric auger, hand-drilling, removal of the drilling bar and the flow of the molten iron from the furnace.

Iron running the length of the main runner at the lower end of the cast house. This shows all of the operations in connection with the opening of the channels into the sows, damming the molten iron in the leader and the flow of the iron into the sows and pig molds. The method of keeping the iron notch of the furnace open, also is shown, and the method of taking samples for the chemist will be illustrated.

Raising a comb of iron, consisting of a sow and whole pigs, preparatory to its delivery to the breaker.

View of the breaker platform, showing the approach of a comb of iron and the breaking of a number of pigs.

View of the chute from the breaker to a railroad car, showing broken pigs in process of being loaded.

Train of ladle cars carrying molten iron from the furnace to the pig casting machine.

Pouring molten iron from the ladle car into a traveling train of molds, showing the passage of the pigs through the cooling tank and up the incline of the casting machine.

View of pigs falling from the end of the casting machine into the car.

View of the canal and dock at the Susquehanna furnaces, showing the method of loading canal boats with pig iron by hand and by the electric magnet. The furnace, ore piles and bridges, and the unloading of an ore boat, can be seen in the distance.

Interior view of a Bessemer converter house, showing the charging, blowing, addition of spiegel to the steel, the discharge of steel from a converter into a ladle and the casting of molten steel into ingot molds.

Ingot molds being transferred to a stripper.

Ingot stripper in operation.

Transferring 3½-ton ingots to the soaking pits.

Opening the covers of the soaking pits, inserting the crane tongs, the removal of the heated ingot, placing it on a buggy and transferring it to a roughing mill.

Buggy discharging the ingot onto the roughing mill train.

Breaking-down a 3½-ton ingot to a 4-inch billet.

A 3-high mill and tilting table, rolling sheet steel piling.

Hydraulic shear cutting 6-inch steel slabs, 27 inches wide.

Hot saw cutting steel rails at the rate of 7 per minute.

Machine for stamping rails and the final rail finishing operations.

A. F. A. Program

TUESDAY, SEPT. 24, 10 A. M.

Formal opening of the convention of the American Foundrymen's Association.

Address of welcome and responses.

Annual address of Major Jos. T. Speer

Report of secretary-treasurer.

Report of the discussion of cast iron at the International Testing congress.

Report of the committee on Coke Analysis.

TUESDAY, 2 P. M.

"Malleable Cast Iron and the Open-Hearth Furnace," by G. A. Blume.

"Memorandum on Titanium in Malleable Castings Practice", by C. H. Gale.

"The Great Economies Effected by Continuous Foundry Installations," by Geo. K. Hooper.

"The Foundry and the Pig Iron Market," by A. I. Findley.

"Mechanical Sand Tempering," by V. E. Minich.

"Compressed Air—A Foundry Necessity," by Arthur F. Murray.

"Heating and Ventilating the Foundry," by W. W. Carrier.

"Melting Scrap," by A. W. Moyer.

"Some Thoughts on the Problems of the Foundry," by C. F. Dudley.

WEDNESDAY, SEPT. 25, 10 A. M.

"Electric Welding," by J. F. Lincoln.

"The Electric Furnace in the Foundry," by F. T. Snyder.

"The Economic Side of the 12-Hour Shift in the Steel Foundry," by R. A. Bull.

"Some Salient Points of the Modern Steel Foundry," by Samuel R. Robinson.

"Open-Hearth Design and Manipulation as Applied to the Foundry," by John Ploehn.

"The Economical Cleaning of Castings," by B. H. Reddy.

"The Effect of Titanium on Convertor and Open-Hearth Steel Castings," by Bradley Stoughton.

Discussion of the Revised Specifications for Steel Castings

"The Bonus System as Applied to the Finishing Department of a Steel Foundry," by A. W. Gregg.

"The Detachable Open-Hearth Furnace," by W. M. Carr.

THURSDAY, SEPT. 26, 10 A. M.

"Lighting Fires in Cupolas," by A. H. Stein.

"Mystery versus Chemistry in Grading Pig Iron," by Thomas D. West.

"Notes on Close-Grained, Soft Cast Iron," by John Jermain Porter.

"Air Required for Combustion in the Cupola and Description of a Steam Blast Gage," by P. Munnoch.

"Government Cupola Melting Tests," by A. W. Belden.

"Rational Cupola Melting," by Richard Moldenke.

"Accident Prevention and Safety Devices for the Foundry," by A. Cameron.

"Instructions in Foundry Practice at the Wentworth Institute," by Prof. E. A. Johnson.

THURSDAY, 2 P. M.

"Patternmaking," by James Glass.

"The Recovery of Shot in Small Foundries," by S. A. Capron.

"Sherardizing," by Thos. Liggett Jr.

"Some Short Cuts in the Foundry Laboratory."

"The Importance of Dispatching in the Foundry," by C. E. Knoeppel.

Discussion of Molding Sand Tests.

The Exhibits

Foundry supplies and equipment will be displayed by the following manufacturers:

American Vanadium Co., Pittsburgh.
Arcade Mfg. Co., Freeport, Ill.
Autocall Co., Shelby, O.
Automatic Transportation Co., Buffalo.
Baird & West, Detroit.
Bartley, Jonathan, Crucible Co., Trenton, N. J.
Bennett-O'Connell Co., Chicago.
Berkshire Mfg. Co., Cleveland.
Besley, Chas. H., & Co., Chicago.
Birkenstein, S., & Sons, Chicago.
Blystone Machinery Co., Cambridge Springs, Pa.
Brady Foundry Co., Chicago.
Brown Specialty Machinery Co., Chicago.
Buch's, A., Sons Co., Elizabethtown, Pa.
Buckeye Products Co., Cincinnati.
Buffalo Forge Co., Buffalo.
Buffalo Scale Co., Buffalo.
Canadian Foundryman, Toronto, Ont.
Carborundum Co., Niagara Falls, N. Y.
Castings, Cleveland.
Chicago Pneumatic Tool Co., Chicago.
Cleveland Pneumatic Tool Co., Cleveland.
Cleveland Wire Spring Co., Cleveland.
Columbia Steel Co., Pittsburgh, Cal.
Crawford Oil & Chemical Co., Cleveland.
Curtis & Co. Mfg. Co., St. Louis.
Dalton Adding Machine Co., Poplar Bluff, Mo.
Davenport Machine & Foundry Co., Davenport, Ia.
Delevan Mfg. Co., Brooklyn, N. Y.
Detroit Foundry Supply Co., Detroit.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Doggett, Stanley, Co., New York.
Electric Smelting & Aluminum Co., Lockport, N. Y.
Federal Foundry Supply Co., Cleveland.
Felt & Tarrant Mfg. Co., Chicago.
THE FOUNDRY, Cleveland.
Gardner Machine Co., Beloit, Wis.
General Electric Co., Schenectady, N. Y.
Gill Clay Pot Co., Muncie, Ind.
Goldschmidt Thermit Co., New York.
Graceton Coke Co., Graceton, Pa.
Hauck Mfg. Co., New York.
Herman Pneumatic Machine Co., Zelienople, Pa.
Hill & Griffith Co., Cincinnati.
Hunter Saw & Machine Co., Pittsburgh.
Ideal Furnace Co., Chester, Pa.
Ingersoll-Rand Co., New York.
International Molding Machine Co., Chicago.

Inter-State Sand Co., Zanesville, O.
Iron Age, New York.
Iron Trade Review, Cleveland.
Kellogg, Spencer, & Sons, Buffalo.
Lincoln Electric Co., Cleveland.
Lupton's, David, Sons Co., Philadelphia.
McCormick, J. S., Co., Pittsburgh.
Macleod, Walter, & Co., Cincinnati.
Metal Industry, New York.
Midland Machine Co., Detroit.
Monarch Engineering & Mfg. Co., Baltimore.
Mott Sand Blast & Mfg. Co., Chicago.
National Lead Co., New York.
New Haven Sand Blast Co., New Haven, Conn.
Norton Co., Worcester, Mass.
Obermayer, S., Co., Cincinnati.
Ohio Mfg. Co., Painesville, O.
Ohio Sand Co., Conneaut, O.
Osborn Mfg. Co., Cleveland.
Pangborn, Thos. W., Co., Hagerstown, Md.
Paxson, J. W., Co., Philadelphia.
Peerless Parting Co., Ottawa, Ill.
Peterson-National Co., Chicago and Buffalo.
Pickands, Brown & Co., Chicago.
Piel, G., Co., Long Island City, N. J.
Pridmore, Henry E., Chicago.
Robeson Process Co., Au Sable Forks, N. Y.
Rogers, Brown & Co., Cincinnati.
Sand Mixing Machine Co., New York.
Sellers, Wm., & Co., Philadelphia.
Sly, W. W., Mfg. Co., Cleveland.
Smith, J. D., Foundry Supply Co., Cleveland.
Smith, R. P., & Sons Co., Chicago.
Standard Alloys Co., Pittsburgh.
Standard Linseed Co., Cleveland.
Standard Sand & Machine Co., Cleveland.
Sterling Wheelbarrow Co., West Allis, Wis.
Stevens, Frederic B., Detroit.
Superior Sand Co., Cleveland.
Tabor Mfg. Co., Philadelphia.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
Trout, H. C., Co., Buffalo.
United States Graphite Co., Saginaw, Mich.
Vulcan Engineering Sales Co., Chicago.
Wadsworth Core Machine & Equipment Co., Akron, O.
Whitehead Bros. Co., Buffalo.
Whiting Foundry & Equipment Co., Harvey, Ill.
Wiener Machinery Co., New York.
Wright Mfg. Co., Lisbon, O.

Some Causes of Blow-Holes

In his presidential address, delivered at the annual meeting of the Sheffield Branch of the British Foundrymen's Association, Percy Longmuir spoke on "The Development of Iron and Steel Founding". He said that the porosity of molds and cores is the chief solution of many defects in molding. A porous mold readily takes care of the air displaced by the metal and the gases generated by casting. A porous mold will not necessarily remove gases contained in the metal before casting and hence blow-holes are divided into two classes, namely, those due to the mold and those due to the metal. Any cause of disturbance in the mold that leads to bubbling might result in entrapping the gases. The source of blowholes and scabs is somewhat similar, but scabs are formed when the disturbance is sufficiently violent to tear away the sand and thus offer a route for the escape of the gases. In both gray iron and brass castings, blow-holes, in the majority of cases, are due to the mold and not to the metal.

Green Sand Molds

A green sand mold rammed too hard or too damp will blow. Local hard spots will cause disturbances and the resulting blow-holes are due to entrapped metal gases and not to the formation of steam. Local wet spots lead to the formation of steam which cannot escape, and is, therefore, entrapped in blow-holes. If generated in large quantities it is ejected from the metal through the gate. Any metal parts of a mold, such as chills, spindles, rods, etc., will create blow-holes unless free from rust and moisture. It is good practice to heat metallic cores or chills. A green sand mold should be cast quickly after a warm core or chill has been inserted, otherwise moisture will condense and blow-holes will result. The cause of blow-holes can be ascertained generally from their appearance. If these defects are caused by the mold they will be oxidized, but if caused by the metal, they will be bright and free from oxidation.

After the mold is poured, three important stages follow, which include shrinkage, contraction and warping. Shrinkage and contraction are often confused, but while related, they represent different actions. Shrinkage refers to the gradual reduction in the volume of the fluid metal as it approaches the solidification point, when shrinkage ceases and contraction begins. Contraction, it was stated, represents the lessening in length or in volume of the solid material as it approaches atmospheric temperature. Warping is merely unequal contraction induced by different thicknesses of metal in the casting. It is easy to measure total contraction, but liquid shrinkage cannot be measured so readily. Shrinkage is prevented by the addition of fluid metal at the proper time. Feeding is an art requiring much greater attention than it has so far received, and systematic study of this practice will give profitable results.

Contraction

Contraction is a natural function and should have full sway in every casting, otherwise either blow-holes or stresses will result. Contraction can be assisted by providing yielding cores and molds, or by loosening all parts that might retard movement in the casting. In some cases the trouble is due to defective design and attention to the mold could not be expected to provide a remedy. Changes of thickness in patterns should be gradual to avoid planes of weakness in the castings. Faulty pattern design is developed readily in castings subjected to water or steam pressures, as in such cases the castings are temporarily extended by the pressure, which intensifies local defects.

Mr. Longmuir said that a problem confronting every iron and steel foundryman is oxygen, or rather dissolved oxide. Oxidized metal, however, does not necessarily imply blown metal. For example, copper castings might be perfectly free from blow-holes and yet be saturated with oxide to the point of harshness and dryness. Excess of oxygen in the metal induces red-shortness, a point of little moment to the founder, but at atmospheric temperatures an excess of oxygen is shown in dry fractures and low percentages of elongations. With gray

Program, American Institute of Metals

TUESDAY, SEPT. 24, 2 P. M.

Official chemist's report.

"History and Achievements of the Institute of Metals of Great Britain," by G. Shaw Scott.

"Work of the Bureau of Mines as it Relates to the Non-Ferrous Metal Industry," by Prof. C. L. Parsons.

Miscellaneous business.

WEDNESDAY, SEPT. 25, 9:30 A. M.

"The Electric Furnace for Melting Non-Ferrous Metals," by G. H. Clamer and Dr. Carl Hering.

"The Electric Melting of Copper and Brass," by C. A. Hansen.

"The Successful Handling of Manganese Bronze and Other Alloys in a Reverberatory Furnace for Foundry Tests and Foundry Practice," by W. R. Dean.

"The Vaporization of Metals," by Dr. J. W. Richards.

THURSDAY, SEPT. 26. 9:30 A. M.

"The Thermal Diagram, With Special Reference to the Bronzes," by Dr. W. E. Campbell.

"Progress of Work on Boron Suboxide as Used as a Deoxidizer in Non-Ferrous Metals," by Dr. E. Weintraub.

"Test Bars for Non-Ferrous Alloys," by Jesse L. Jones.

"Phenomena Connected With the Tarnishing of Metals," by C. F. Burgess.

"The Influence of Pouring Temperature on Manganese Bronze," by H. W. Gillett.

"Adulterated Core Flours," by H. W. Gillett.

"Metallic Cobalt," by Herbert T. Kalmus.

FRIDAY, SEPT. 27, 9:30 A. M.

"The Difficult Art of Casting German Silver," by C. P. Karr.

"Commercial Alloys and the Use of Rare Elements," by Dr. A. Hirsch.

Election of officers.

iron, owing to the manganese and silicon present, the oxide problem during melting is of less importance. In the cupola, the presence of a slightly oxidizing atmosphere is shown by the manganese and silicon losses. Some irons are reported to be stronger than others of the same composition, and this probably is due to the absence of oxide. If oxygen is present in cast iron it is, in all probability, there before it has been passed through the cupola.

Dull Iron and Cupola Bridging

By W. J. Keep

Question:—We are melting daily about 40,000 pounds of iron in a cupola lined to 46 inches. Our melting speed is about 7½ tons per hour, and the iron is quite hot and satisfactory, except toward the latter part of the heat, when it becomes dull. We are using about 70 pounds of good limestone for each ton of iron and we begin charging this flux after 5 tons of iron have been charged. The slag flows freely until toward the latter part of the heat. When the blast is shut off the slag appears to run down the sides of the cupola through the tuyeres and into the wind box. The cupola, also, will not drop clean. Large quantities of thick, gummy slag remain in the cupola and it is quite difficult to break this slag. We have found that it contains also a considerable quantity of iron. It seems to us that the cupola begins to bridge soon after melting 16 or 17 tons of iron and that this bridge is held up by the pressure of the blast, which results in slow melting, dull iron, and also stops the flow of slag.

Answer:—While these difficulties were discussed in the February, 1912, issue of THE FOUNDRY, it seems that these troubles are so generally experienced, that further suggestions should be given for overcoming these cupola problems. Coke containing sulphur, 0.75 per cent; ash, 10.12 per cent or even 13 per cent and volatile matter, less than 1 per cent, will prove satisfactory for foundry use. If the volatile matter is much in excess of 1 per cent the coke will melt into a thick mass similar to coal tar and either will be chilled solid by the blast or will be blown up through the charges and chilled, and in that way will become cemented together. Consequently, the melting will be slow, as the blast cannot penetrate this mass. The temptation is to increase the blast pressure, which results in further difficulties. High blast sometimes results in a foamy slag which frequently rises to the charging door and flows out onto the charging platform. When the blast is shut off the slag drops down and fills the tuyeres before the bottom can be dropped and the chilled slag above forms a strong bridge or scaffold.

There must be a sufficient amount of ash in the coke to give it strength to hold up the weight of the charges. In cold weather the moisture in the coke is invariably high and the frost in the coke frequently breaks it into small pieces as the melting zone is approached. If the ash is low, the coke will be so weak that it will be crushed by the iron charges and will thereby prevent the free passage of air.

In addition to the recommendations made in the February issue of THE FOUNDRY, regarding slagging, the following is offered: The blast from the tuyeres is deflected downwardly, if it is difficult for the air to pass up through the charges and thus it will chill the upper surface of the slag which lies on the molten iron. The slag hole should be about 3 inches in diameter inside of the cupola and the top of this opening should be located about 4 inches below the lower edges of the tuyeres. There should be no tuyere opening directly over the slag hole. With a considerable blank space in the cupola above the slag opening the slag will flow toward this opening without chilling. Generally, the tap hole for the iron is so large that when the iron is drawn off the bath of molten metal becomes so low in the cupola that the slag stops running. Of course when the tap hole is stopped-up, the molten iron in the bottom of the cupola will rise, carrying the slag with it, which will again flow when it reaches the level of the slag opening. The slag should be tapped as soon as it will flow. Limestone should be charged with the first coke charge so that the first slag will be fluid. If the blast enters the cupola at a point too near the slag hole, a number of tuyere openings should be closed up on either side to prevent the chilling of the slag. If the iron is still dull at the end of the heat, the coke charges should be slightly increased. However, under proper melting conditions, the last iron should come down hot with a smaller amount of coke than is used in the earlier charges.

Twenty tons of iron is rather a large heat for a cupola lined to 46 inches and great care must be exercised to tap off the slag as rapidly as it is formed. However, 70 pounds of limestone are more than are necessary, if it is of a good grade. If the slag is sufficiently fluid, all of the molten iron will pass through it and practically no iron will be contained in the slag.

Leaky House Heating Boiler Castings

By W. J. Keep

Question: — We manufacture castings for house heating boilers, but these are porous and we experience considerable difficulty from small leaks. Our iron appears to be dirty. We skim carefully and also use skimming gates. The analysis of our pig iron follows: Silicon, 2.05 per cent; sulphur, 0.028 per cent; manganese, 1.50 per cent and phosphorus, 0.41 per cent. We use one-third pig iron, one-third chilled car wheel scrap and one-third No. 1 machinery scrap. Limestone is used for fluxing the metal.

Answer: — Why give the analysis of your pig iron when two-thirds of your mixture is an unknown quantity? You might as well guess at the analysis of your entire mixture. The pig iron is low in phosphorus and all of the scrap you are employing likewise contains a low percentage of this element. The silicon also is too low for castings of this type. Both car wheel and machinery scrap are comparatively high in sulphur. Owing to the large amount of manganese also contained in this mixture, it will be difficult to imagine how you could obtain a much more unsuitable mixture for this purpose. It would be advisable to purchase pig iron containing silicon from 2.75 to 3 per cent, manganese 0.75 per cent, and phosphorus as high as 1 per cent. The remaining two-thirds of the mixture then could consist of scrap. The castings should be analyzed and if the silicon is below 2.50 per cent and the phosphorus less than 0.75 per cent, add a softener to increase the silicon to 2.75 per cent. The silicon and phosphorus will have a tendency to make the iron fluid in the ladle and it will be in such condition that the dirt and slag readily can be skimmed off. It might be claimed that such a high percentage of silicon will make the iron too open and porous. However, if the patterns are so designed that all parts are of nearly the same thickness, little trouble will be experienced. You should use non-chilling irons for castings that are to withstand wide variations in temperature and for this reason you should not employ car wheel scrap.

Economical Operation of Molding Machines---I

How These Foundry Labor-Saving Devices Should be Equipped to Produce the Best Results, With Notes on the Mounting of Patterns

By W S Otto

This is the first of a series of articles on molding machine practice which will consider in detail every phase of this work. The various types of machines will be discussed, and suggestions will be made for mounting patterns to produce the work to the best advantage. No particular types of machines will be recommended, but the author will draw upon his wide experience in molding machine operation to point out how the greatest economies were effected on certain classes of castings.

As far as possible, each installment of this series will constitute a separate article devoted to a discussion of a certain branch of this practice. To obtain the best results from molding machine operations involves the proper mounting of patterns and the employment of the necessary rigging. The author will describe how to mount wood and metal patterns on machines, how to make sand, plaster and metal matches and will direct attention to common errors that should be avoided by foundrymen who are novices in molding machine practice. The employment of these labor-saving machines in jobbing shops also will be discussed and the labor difficulties frequently arising as a result of the adoption of machine methods will be treated at length.

LABOR-SAVING molding equipment today constitutes one of the most important essentials of successful foundry practice and to obtain the greatest economies that can be effected, a knowledge of the operation of molding machines, their application to different classes of work and the mounting of patterns is required by the foundry operator. In recent years the demand for castings has increased greatly and the production of foundries has grown to such proportions that it would be impossible to make these castings by hand, as the supply of skilled molders has by no means been increased in proportion to the growth in the output of the casting industry. It is only natural, therefore, for foundrymen to adopt methods of increasing their output, at the same time keeping in mind the fact that they must reduce the manual labor of the molder in order to increase their tonnage most advantageously.

First Mechanical Molding Device

While the history of the foundry industry does not accurately record the time of the adoption of the first mechanical molding device, nevertheless it can be stated fairly that the stripping plate machine was among the first to be extensively employed commercially for the purpose of minimizing the manual labor of molding. The theory which led to the development of this type of machine was that by drawing the pattern mechanically, and by leaving the mold in a perfect condition, the molder would be relieved of patching, thereby greatly reducing his labor. Furthermore, it was assumed that a more perfect mold would be obtained than when made by hand and the saving in time effected would enable the operator to increase his output. Therefore, it is apparent, that in the early days of molding machine manufacture, the aim was to increase the output per operative and at the same time to obtain better castings.

After relieving the molder of the operation of drawing the pattern it was only natural that development would be along lines of further reducing his manual labor. After the introduction of the stripping plate, followed the squeezer and machines of the roll-over type. The squeezer for bench work was intended to relieve the molder of a part of the ramming and as the lever-locking device was used, it was assumed that each mold would be of a uniform and proper compactness, thereby reducing strains to a minimum. The roll-over type was designed to roll the mold over, as well as to draw the pattern, thereby reducing the manual labor of molding considerably. However, the main object of the roll-over type was to obtain a machine which would leave the mold right side up when the pattern was drawn. This, it will be readily understood, applies to the drag half only and it was this section of the mold that the roll-over machine was intended to handle.

Molding machines generally are divided into four distinct classes, including the stripping plate and roll-over, jar-ramming, squeezer and gravity machines. There are various combinations of these different types, but in general the machines may be classified under these four different groups. Stripping plate and roll-over machines are essentially of the pattern-drawing type and do not eliminate hand-ramming. However, they greatly simplify the molding operation, as they provide for drawing the pattern without the slightest injury to the mold or in any way disturbing the sand. It is apparent, therefore, that a highly skilled mechanic is not required to operate one of these machines, as the mold does not require patching after the pattern is drawn. Patching the mold neatly and accurately reflects the true art of the molder. Inasmuch as the pattern is machine-drawn and no patching is required, considerable time and trouble are saved the molder, permitting him to proceed at a much more rapid pace than if he were compelled to spend valuable time repairing portions of the mold that had been torn away while drawing the pattern.

Stripping Plate and Roll-over Combination

The stripping plate and roll-over machines are used together to advantage. The roll-over machine is employed for making the drag and the stripping plate for making the cope. The drag necessarily must be rolled over and it is obvious, therefore, that the roll-over machine leaves the drag section of the mold in its natural position for setting-off and coring up. In the case of the cope the reverse holds true, as it must be set over the drag in position for pouring with the same side up as when it was rammed. Therefore, it is evident that if the cope were made on a roll-over machine it would have to be rolled back again into position for setting it over the drag when closing the mold. This extra handling of the cope involves an unnecessary loss of

time. As the stripping plate machine does not roll the mold over, and by making the cope on this type, one handling of the mold is saved.

The feasibility of always stripping the cope and never rolling it over is a point that is frequently disputed. However, on many jobs requiring cores in the cope, it would seem that this part of the mold necessarily must be rolled over and many contend that it is necessary to roll the cope to permit the molder to properly finish and blacken this part of the mold.

Cored Copes

However, when making the cope on a stripping plate machine, particularly if cores are set in this part of the mold, it is by no means necessary to roll the mold over. By bolting two wrought iron braces to the side of the machine in such a manner that they will form a 15-degree angle and at the same time having the apex of the angle meet the surface of the plate, it will be found that the cope can readily be tilted on edge. While in this position it can be blackened either with a brush or bag and the cores can be set. Unless the mold is unusually large, one man can readily tilt over the cope onto the braces and while it is in this position, he can easily set the cores and blacken the mold.

Those experienced in the mounting of patterns on molding machines know that provision can be made for carrying the core on the cope plate or on the pattern. Let us assume, for example, that we are mounting a job that has an arm or boss on the cope that overhangs. In this instance a core is necessary and this usually is the result of intricate machine design. A core box is made to take in the entire section of the boss or arm that overhangs, but no print is placed on the pattern. A small portion of the arm or some other projection is used to locate the core when it is set on the pattern in its proper position and provision also is made for holding it while ramming. This practice is commonly termed ramming a core in green sand. Care must be exercised, of course, to prevent hitting the core with the rammer or in any way disturbing its position. For holding these cores in the sand, particularly if they are large and heavy, provision should be made for securing them with nails. If the cores are made with the nails in them they will become firmly set when the core is baked. On heavy cores it is frequently found necessary to provide the core with a hook by which it may be wired to a bar in the cope, or in some cases special projections have to be provided in the flask.

In this connection an error frequently made when mounting jobs for quantity production should be mentioned. The particular job to be referred to involved the use of a cope which would have been a flat-back, but for four pockets or depressions. In order to handle this job, either on a roll-over or stripping plate machine, these pockets had to be secured by nailing and as they were about three inches deep a soldier and gagger had to be used. To secure these pockets required considerable time. In accordance with the practice previously outlined a core box was made to make a core that fitted the pocket perfectly all around, about one inch of the core having projected into the green sand. The cores were nailed with spikes bent at an angle and held firmly while drawing the pattern. This small change resulted in an increase in the output of five molds per day without additional labor and the production on the floor was increased 2,200 pounds.

Jar-Ramming Machine

The jar-ramming or jolt-ramming machine is essentially designed to ram molds. This is accomplished by jarring or jolting the mold to settle the sand around the pattern. The force of the blow can be regulated to obtain any degree of compactness. These machines are used extensively for making large molds, but they are employed also for small molds and cores. The plain types do not roll the mold over, although there are combinations which accomplish the roll-over operation. Very large molds rammed on these machines are rolled over by a crane or air hoist while the copes are lifted off.

It might be well to note that there is a right and wrong way to operate a jar-ramming machine. It seems that in some shops it is customary for the operator to limit his duties to watching the machine while it is in operation. However, this was not the intention of the inventor who designed this type. The class of work, it should be noted, largely determines the method of operation. If a large quantity of castings are to be made from the same pattern, two machines usually are employed, one for the cope and one for the drag. Some foundrymen, on such occasions, prefer to use a stripping plate machine for the cope, particularly if cores are set into this part of the mold for taking care of pockets or overhanging bosses and arms. It should be the policy of the foundryman operating the jar-ramming machine to keep it constantly employed. After the first mold is set-off, the second flask should be immediately set in position on the machine, filled with sand either partly or entirely, whichever is deemed advisable, and the machine should be permitted to operate while the molder is finishing the mold previously set-off. If a helper is employed on the floor it should be his duty to set the flask on the machine and to fill it with sand while the molder is finishing and setting the cores in the mold previously made. The point to be guarded against is not to permit the machine to stand idle while the molder is finishing a mold already made.

Operating One Machine Economically

When it is possible to make only two or three molds per day, owing to the size of the work, it is by no means a paying investment to operate two machines on the same job, especially when the amount of finishing and core-setting is in any way excessive, as the machine will make the molds much more rapidly than it is possible for them to be finished. Under such conditions, in most shops operating only one machine, the necessary drags for the day's work are rammed, after which the patterns are changed and the copes are made. By following this mode of procedure the drags that have been finished must remain open until the copes can be rammed. In some instances this is a dangerous procedure, as particles of dirt are liable to fall into the mold and parts of the mold may become air-dried. In some plants, owing to unclean shop conditions, the writer has had occasion to change this mode of procedure, closing the molds as fast as they are made in order to obtain clean castings. To eliminate the loss of time in changing the patterns from drag to cope the machine table was grooved with a T-slot inverted on each of its center lines, the flask pin holes having been used for jigging points. Corresponding grooves were cut into the parting of the pattern, both in the cope and drag. The grooves in the pattern need only be cut about 2 inches in length, but should be extended to the extreme edge of the parting. In this groove is inserted an I-shaped feather which engages the grooves on the table plate as well as the grooves in the pattern partings. As the grooves in the table plate are accurately centered and are at right angles, it is ap-

parent that no shift or mis-matching is possible as long as the grooves in the pattern partings match with each other. By this arrangement it is possible to change from drag to cope and back again with no apparent loss of time as neither bolts nor dowel pins are used. The change from one job to another also can be made easily, thereby allowing different jobs to be run on the same floor and on the same day without loss of time in changing patterns, which is essential in many shops to effect a saving in flask equipment.

Condition of the Sand

The condition of the sand used on jar-ramming machines should receive constant and careful attention. When ramming by hand the foundryman often is not very particular as to the openness of his sand. It is well-known that the longer the sand is used and the more it is burned, the closer it becomes in texture. When hand-ramming, this can be overcome to a certain extent by the molder when ramming. However, the jar-ramming machine will ram every mold to the same compactness, regardless of the nature of the sand, unless the machine is adjusted or operated to meet the varying conditions of the sand and pattern. In several instances, where blow-holes were occurring on castings made on jar-ramming machines, the trouble was traced to the sand and not to the machine, as believed by the foundrymen experiencing this difficulty. However, until the trouble was remedied by opening the sand the machine was forced to stand the blame. In some cases pattern changes also are necessary. Occasionally a deep pocket is found on the pattern with its sides inclined to a common point. When this occurs, especially in a large mold requiring an extra amount of ramming, the point of the pocket is liable to become too hard, causing a blow-hole. When this condition arises, either the pattern must be filled up, and sometimes this cannot be done, or the sand must be opened. In opening the sand to favor the pocket this may be overdone to such an extent that other portions of the mold will scab. When this condition arises it is necessary for the molder to use a special mixture of open sand for the pocket only, making the remainder of the mold from the regular sand mixture.

The old saw that a man does not receive credit for prevention holds good in the foundry as well as in other lines of work and all credit comes to him who is able to effect a cure. However, the foundryman who never has any trouble to overcome is the one who is using his gray matter to prevent it instead of waiting to use his scrap heap as a barometer of the cure he should apply. It is advisable for the foundryman to carefully study the nature of his job so that he may be able to take proper precautions to prevent any trouble that may arise.

The squeezer type of molding machine rams or squeezes the mold by one movement, whereas by hand a series of movements with the rammer is required. Frequently, many jolts involving the production of a large number of castings are made with a match, that is, the patterns are run on a follow-board. This seems to be a waste of time for almost any quantity of castings, however small. It requires two movements for any mold where only one is necessary. By the use of the metal match-plate the operator can squeeze both drag and cope by one movement. In addition, more perfect molds are made and considerable expense in cleaning is saved, as the castings will usually be free from fins. In following the match-plate process, care must be exercised not to match a job which is too difficult to handle. Frequently it has been found advisable to take a match-plate and to make match halves so as to divide the job between two machines and in this way the production is increased four-fold.

The Gravity Machine

The gavity molding machine, as its name implies, packs or rams the sand around the pattern by gravity when permitted to fall from a certain height. The same effect is obtained as when a molder throws a handful of sand onto a corner of a pattern to make it secure. The employment of this machine on certain classes of work greatly facilitates molding operations. As the sand is mechanically elevated, the molder is relieved of the work of filling the flask by hand. When two men are running a job one can be employed making molds continuously while the other is closing. This applies, of course, to the employment of patterns from which both cope and drag are rammed. The gravity system of molding is employed on a stripper and roll-over basis and works as well on one as on the other. When the machines are installed in a shop in battery formation and connected to a sand conveyor they form a combination that effects considerable molding economies.

Gray Iron Castings for Chemical Work

By W. J. Keep

Question:—We would like a mixture for castings to be used in chemical work, particularly retorts.

Answer:—Retorts are usually quite large and the walls invariably are about 1½ inches thick. To avoid porous spots, these castings should have approximately the following analysis: Silicon, 1 to 1.40 per cent; phosphorus, below 0.25 per cent; manganese, below 0.60 per cent and sulphur, below 0.07 per cent. The coke used for melting the iron should not contain more than 0.75 per cent sulphur and oyster shells or a high grade limestone should be used as a flux. Thirty pounds of flux should be used for each ton of iron melted. This flux should be spread on the coke before the iron is charged and it will absorb some of the sulphur contained in the coke, although the iron will likewise absorb sulphur, and the amount contained in the melted iron will be increased about 0.04 per cent. In making your mixtures it is well to remember that in addition to the increase in sulphur there will be a loss of silicon of approximately 0.30 per cent. When charging, care should be exercised to prevent dropping dirt from the platform into the cupola. The iron should be melted hot and should be permitted to cool slightly before pouring. The castings should be gated in such a way that the gates enter the molds at the bottom and they should be of such a size that they can be kept full of iron while pouring. When pouring, the iron should flow in a full, steady stream. A large casting, with walls 1½ inches thick, should not contain more than 1 per cent silicon. The heavier the casting the lower the silicon content. Great care must be exercised in producing castings for chemical work. It might be advisable not to use any scrap except that produced in your shop. After you have succeeded in obtaining a good mixture, outside scrap might be used to reduce the cost of your metal.

The Delevan Mfg. Co., successors to the W. H. Stewart Mfg. Co., 65-69 Delevan street, Brooklyn, N. Y., recently has issued an interesting booklet entitled "Those Cores." It contains many interesting facts relating to liquid core compounds and the manufacture of cores. At the Buffalo convention the company will be represented by Arthur R. Townsend, president, and Wm. H. Stewart, secretary.

A Crucible and Converter Steel Casting Shop

How the Two Processes Are Advantageously Combined in the Plant of the Chicago Steel Foundry Co.

IN THE leading article published in the September issue of THE FOUNDRY, attention was directed to the progress that has been made recently in the crucible steel castings industry. The special demand for high grade steel castings created by the growth of the automobile business and the great advances made in the design and capacity of agricultural machinery was mentioned. Although this demand is met, to a large extent, by the modern crucible steel foundry, yet there are limitations to the crucible process which prevent it from entirely covering the field. Crucible castings are limited in weight, even the most modern shops not attempting to handle jobs where the individual pieces weigh over 500 pounds, while the great majority of the work runs under 100 and even less than 50 pounds per casting. Crucible castings also, on account of the nature of the process, are comparatively high in price. The crucible furnace does not permit the removal of impurities in the steel by oxidation and it is, therefore, not always possible for the crucible foundryman to turn out castings of exactly the composition desired on account of the limitations in the supply of raw material.

To obviate these disadvantages and to provide castings of approximately crucible quality at less cost, the small Bessemer converter is being employed successfully in a number of shops in the west. In fact the crucible furnace and the converter make an ideal combination for a steel foundry specializing in light, high-grade automobile castings, agricultural work, etc. If especially pure metal is desired, the price being a secondary consideration, the castings may be made with crucible steel; where quality is not quite so essential and price is more important, also when larger castings are needed and time is an important factor, the converter can be employed to advantage. In either case the molding practice is essentially the same and molds which are properly made may be poured with safety either with converter or crucible steel.

The Plant

A new plant designed along these lines to produce both Bessemer and crucible steel castings has been erected recently by the Chicago Steel Foundry Co., at Kedzie avenue and Thirty-ninth street, Chicago. The location of the shop is especially favorable, the district being devoted almost entirely to foundries and the supply of labor is correspondingly good. Railroad connections also are excellent.

The building, which was designed by Raeder & Wood, architects and engineers, Chicago, is of the standard steel frame construction with a gabled monitor over the main bay and lean-to roofs over the two side bays. The building is 201 feet 9 inches long and 101 feet, 11 inches wide, the main bay being 40 feet and each of the side bays 30 feet in width. The north side bay is occupied by the cleaning room, furnaces, drying ovens and core department, the molding being confined to the center and south bays. A separate structure, 142 feet long and 30 feet wide, has been built along the north side of the building to house the shipping department, sand blast room, brick and sand bins. The general arrangement of the plant is shown in the plan, Fig. 12. The walls of the building are of brick with cut stone trimmings and metal sash. The roof consists of reinforced concrete slabs furnished by the Federal Cement Tile Co. The structure is absolutely fireproof.

The foundry is designed to turn out either crucible or converter steel

FIG. 1—GENERAL VIEW OF THE MAIN BAY OF THE CHICAGO STEEL FOUNDRY CO.'S PLANT, SHOWING THE ANNEALING OVENS, CRUCIBLE FURNACES, CORE DEPARTMENT AND MOLDING FLOOR

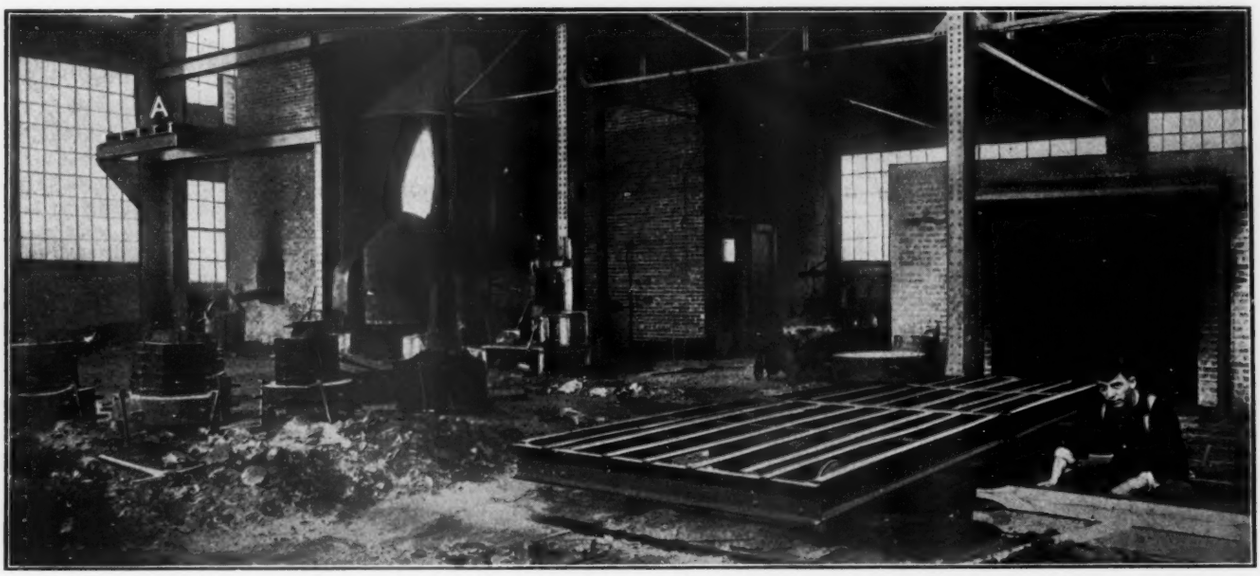


FIG. 2—ONE SECTION OF THE CHICAGO STEEL FOUNDRY CO.'S PLANT, SHOWING MOLD DRYING OVEN, CONVERTER AND CUPOLA CHARGING PLATFORM

castings from one-sixth of a pound up to a ton in weight. The average weight of the output per casting at present is 6½ pounds. For melting steel, four 6-pot crucible furnaces of the improved Milwaukee type and a one-ton Tropenas side-blow converter with cupola have been installed.

The crucible furnaces have three-pan Mitas type oil burners and a single melting chamber holding six pots, the design being similar in general to the furnaces described on pages 341 and 342 of the September issue of THE FOUNDRY. They are approximately 9 feet long, 5 feet wide and 6 feet deep each and project a foot above the floor line. The melting chamber is 4½ feet long, 3 feet wide and 36 inches deep. In front of each furnace is an ash pit for cleaning purposes and a cleaning pit is also placed between each group of two furnaces. The foundations rest on hard pan and the entire battery is surrounded by a light concrete retaining wall. The furnaces connect with a single flue which extends along the rear and terminates in a stack as indicated in Fig. 12. Space is provided for the installation of two additional crucible furnaces when the need for them arises. Each furnace has a capacity of approximately 3,000 pounds of melted steel per day. The crucible steel capacity of the plant is, therefore, 9,000 pounds of melted steel per day, one of the four furnaces generally being shut down and held as a spare.

Tongs are used for lifting the pots, a block and chain tackle being employed. In accordance with the usual practice in crucible foundries, care is taken in the selection of the raw material and generally five heats per day are poured from each furnace.

REPORT OF

CUPOLA CHARGES

191—

Coke		2900	Lbs.
Pig Iron No. 1		2500	"
" " No. 2		3000	"
Steel Scrap		900	"
Ferro-Silicon	11%	130	"
Ferro-Silicon	50%	80	"
" Manganese		100	"
Aluminum		4	"
"			Gals.

No. OF BLOW	BLOW STARTED	BLOW ENDED	DURATION OF BLOW	REMARKS
1	1:39	1:51	12	
2	2:10	2:23	13	
3	2:31	2:42	11	
4	3:00	3:16	16	

FIG. 3—DAILY RECORD OF CONVERTER METAL FROM THE CUPOLA

Crucible Mixture

A typical mixture for a 5,000-pound heat is as follows:

	Pounds.
Mild steel boiler punchings	4,240
Returned foundry scrap	1,060
Aluminum	5
Ferro-manganese	18
Ferro-silicon	33

The total weight of the metal charged is 5,356 pounds and the furnace loss is 100 pounds, the weight poured being 5,256 pounds. The details of each day's melt are reported on a special form, Fig. 5, which contains space for the mixture used, together with a record of the number of heats poured from each furnace and the time when each heat is poured. These reports are made out by the melter and are filed with the foundry superintendent daily.

The Converter Department

The Bessemer steel making department is shown in Fig. 2. The equipment includes a one-ton Tropenas converter, the details of which are too well known to require extended description, together with a 36-inch Tropenas cupola and the necessary blowers. The cupola is enclosed and

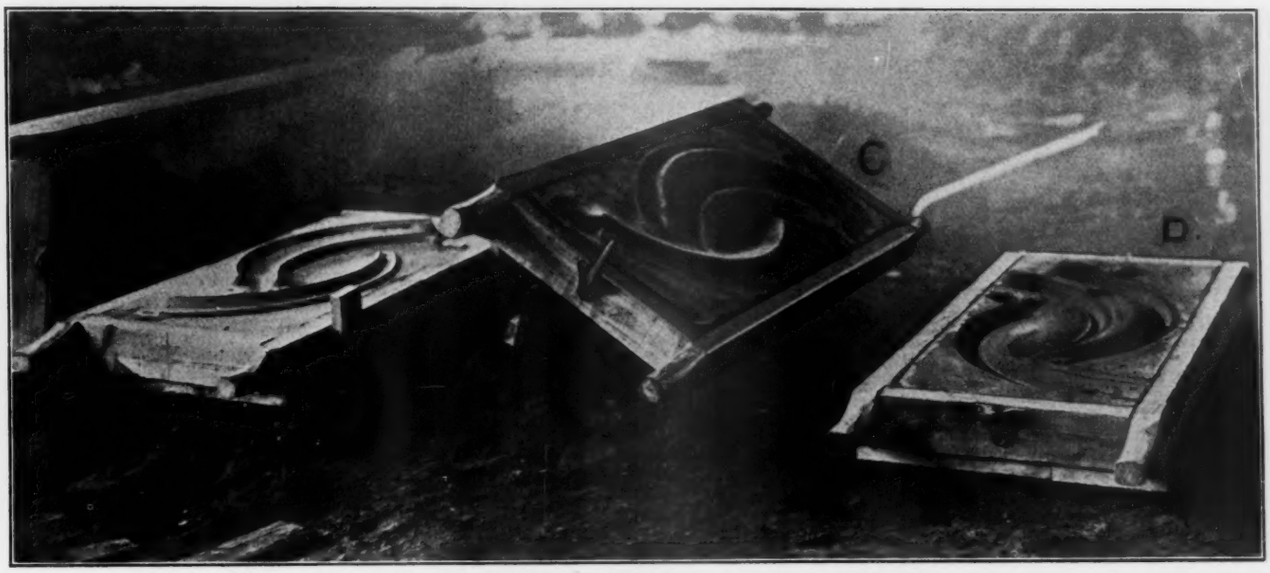


FIG. 4—FLASK CONTAINING MOLD FOR STEEL TIRE FORMS

the relative arrangement of cupola and converter is shown in Fig. 12. This illustration also indicates the arrangement of the blower room, which is located at the rear of the converter. The blast for the cupola is furnished by a Roots, low-pressure, rotary blower, direct connected to a 20-horsepower, three-phase, 220-volt motor, operating at a speed of 1,125 revolutions per minute; blast for the converter is furnished by a Roots, positive, high-pressure blower connected to a 30-horsepower, three-phase, 220-volt motor, operating at a speed of 1,130 revolutions per minute.

Cupola Charging Floor

The cupola charging floor extends out into the main bay under the crane runway, as indicated at *d*, Fig. 2, and the charges are handled by the main traveling crane. For weighing material, a 5-beam platform scale has been installed on the charging floor. The converter is arranged to burn crude oil. An oil house containing two 10,000-gallon tanks is situated alongside the railroad spur, west of the main foundry building. The oil house equipment includes a motor-driven pump with a capacity of 2,000 gallons per hour, used for unloading tank cars. The oil runs from the storage tanks to the converter and to the ladle dryers by gravity.

Converter Heats

Under normal conditions, with the shop operating at capacity, from 8 to 10 blows per day are made in the converter, the product amounting to 12,000 pounds of melted steel. Adding this to the figures for the crucible furnaces mentioned, the total daily capacity of the plant is found to be 10 tons of melted steel, or about 7½ tons of finished castings.

One of the secrets of successful founding with a converter lies in the careful selection of raw material. Although the converter may be used to reduce certain impurities, notably silicon, nevertheless carefully-chosen stock will produce much better castings than material picked up at random. Investigation has shown that in many cases where converter foundries were unsuccessful, the trouble was due largely to careless selection of raw material and improper handling in the converter. It is possible to make steel in a converter that is practically as good as the best crucible product if proper precautions are taken.

The Chicago Steel Foundry pays special attention to the selection of its mixtures for the converter. Only strong, low phosphorus pig iron is used, together with carefully picked scrap. Two kinds of pig iron are generally employed, the first grade containing approximately 2.65 per cent silicon, 0.014 per cent sulphur and 0.027 per cent phosphorus. The No. 2 pig iron averages about 1.57 per cent silicon, 0.036 per cent sulphur and 0.034 per cent phosphorus. A typical cupola mixture from which four blows were obtained between

DAILY CRUCIBLE FURNACE REPORT

CHICAGO STEEL FOUNDRY COMPANY

FURNACE _____ 191__

1	500# AT 6:30	800 10:15	500 2:00	500 4:30			Boiler Punchings	4240#
							Foundry Scrap	1060
2	800 AT 6:30	600 9:30	500 12:00	500 3:00	500 5:30		Aluminum	5
							Manganese	16
3							Silicon	33
							Spiegel	
4							Titanium	
							Vanadium	
5							Crucibles Used	16
							Total Weight Charged	
6							Lost in Furnace	100
							Total Weight Poured	

Remarks _____

FIG. 5—DAILY RECORD OF STEEL MELTED IN CRUCIBLE FURNACES

FIG. 6—SHEAR FRAME MOLDED ON THE FLOOR

1:39 p. m. and 3:17 p. m., was as follows:

	Pounds.
Connellsville 72-hour foundry coke	2,900
No. 1 pig iron (see analysis above)	2,500
No. 2 pig iron	3,000
Low phosphorus steel scrap	900
11 per cent ferro-silicon	130
50 per cent ferro-silicon	80
80 per cent ferro-manganese	100
Aluminum	4

The blows average 12 minutes each. In order to keep a close watch on the metal run through the converter, a record of the cupola charges is kept on a special blank, Fig. 3. This contains not only space for a complete record of the mixture used, but also data regarding each blow of steel.

Fig. 8 shows an interesting ladle heater that has been installed at the Chicago Steel Foundry. It consists simply of a cast iron, bolted-up box, 10 feet long, 2 feet wide and 2 feet high, lined with clay and fire brick. An oil burner, *B*, Fig 8, is placed at one end and is arranged so that it raises the entire interior chamber to a white heat. Six openings over which the ladles may be inverted are placed along the top of the dryer as indicated. This apparatus is economical in oil consumption, very convenient and has a large capacity, being able to handle half a dozen ladles at once.

The foundry has a molding floor area of 12,700 square feet. The small molds are made at the bench in snap flasks. Larger jobs, or special work where only a few castings are required, are handled on the floor and a jarring machine is used for the large amount of the heavier work. The main bay is served by a 5-ton Whiting traveling crane having a span of 40 feet.

FIG. 8—OIL-BURNING LADLE DRYER

FIG. 7—CRANE REMOVING MOLD FROM PRIDMORE ELECTRIC JARRING MACHINE

Fig. 4 shows the cope and drag, together with the follow-board and patterns used for molding cast steel tire forms for a patented anti-puncture device for automobile tires. There are three castings in each flask, the flasks being 24 x 36 inches. The drag is shown at *D*, the cope at *C* and the patterns in the follow-board, at *F*. The latter is a dry sand mold made in a flask provided with a suitable bottom board as shown in the illustration. The drag is placed over the follow-board with the patterns in place and is rammed up in the usual manner, after which it is rolled over, the follow-board removed and the cope fitted in its place.

As shown in Fig. 4, there is a separate runner and gate for each of the three castings in the flask. The practice of using dry sand molds

as follow-boards is general in this shop. It is said to result in considerable economies compared with the old method of carving each follow-board out of wood. The castings, shown in Fig. 4, could be made to advantage on the jarring machine except that the order did not cover a sufficient quantity to justify special rigging. Therefore, the job was handled on the floor in the manner described. The molder puts up an average of 15 flasks per day, each containing three castings weighing 10 pounds apiece.

An Intricate Mold

An intricate floor mold poured with crucible steel is illustrated in Fig. 6. The casting is a frame for a small shear and weighs about 200 pounds, the pattern being shown at *P*. The flask is 28 x 40 inches, the drag being 10 and the cope 8 inches in depth. There are seven cores to be set and considerable nailing is also necessary. One man makes two molds per day. The casting is poured through one runner, *R*, and on account of the peculiar shape, risers are not necessary.

FIG. 10—A CORNER IN THE CLEANING DEPARTMENT, SHOWING A NUMBER OF FINISHED CASTINGS

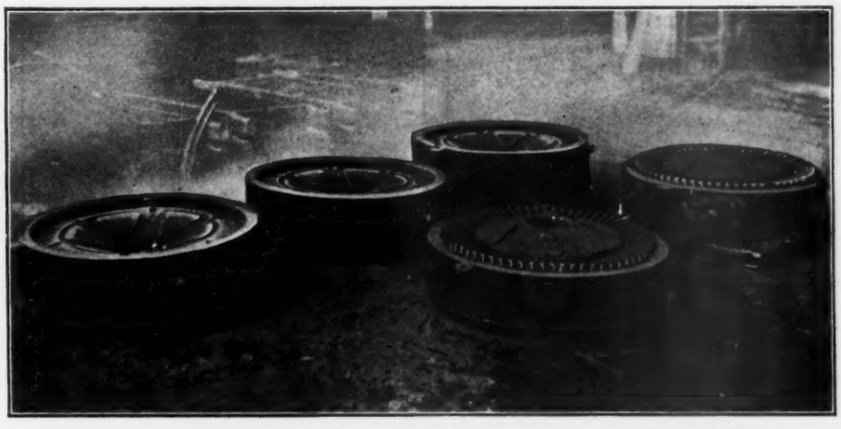


FIG. 9—GEAR MOLDS MADE ON ELECTRIC JARRING MACHINE

Fig. 7 illustrates the Pridmore electric jarring machine that is used for a large majority of the work. In this illustration one of the circular gear molds shown in Fig. 9 is suspended from the crane. The mold is rolled over in the air while hanging in the crane yoke. The gear molds, Fig. 9, are made with a metal pattern, the teeth being formed in the drag and the back of the gear in the cope. Each gear is 36 inches in diameter and weighs about 200 pounds. It is provided with a long, heavy hub that makes it particularly difficult to mold and cast.

A couple of the finished gears are shown at *G*, Fig. 10, while the completed molds, with the core boxes for the hubs in place, are in front of the converter in Fig. 2. Before being closed, the molds are clay-washed and are placed in the oven shown in the background in Fig. 9, where they are thoroughly dried. Each mold is bumped on the jarring machine for about 30 seconds and with the aid of the machine one molder and two helpers finish 14 flasks per day. In doing this work by hand without the machine, two molders and two helpers were able to turn out only seven flasks per day.

The automobile gear case, *S*, Fig. 10, is also molded on the jarring machine at the rate of 48 minutes per flask. By hand, the maximum production on this job, employing

FIG. 11—FIREPROOF PATTERN STORAGE VAULT

a molder and a helper, was seven flasks in two days.

Special attention has been given to the sand storage arrangements and five reinforced, tile-lined bins have been constructed in the room behind the crucible furnaces, as indicated in Fig. 12. Three of the bins are 20 feet square and the other two are 9 x 20 feet, each bin being practically 8 feet deep. For annealing the steel castings an oil-burning oven, shown at the right in Fig. 1, has been erected. The oven is 6 feet long, 4 feet wide and 4 feet high inside.

Cleaning Department

The cleaning department occupies a room 26 x 36 feet, located as indicated in Fig. 12. Immediately adjacent to the cleaning room is the shipping department which occupies an equal space. The sand blast room, 10 x 19 feet, is situated in the lean-to west of the shipping department and communicates with a vault 18 feet square, used for the storage of crystal silica sand. The equipment of the cleaning department includes two 28-inch double emery grinders, Fig. 10, two power hack saws, a punch, cut-off saw and the usual equipment of tumblers, benches, chipping hammers, etc. The sand blast room contains a Pangborn sand blast machine, together with a bench and the necessary exhaust hood.

Core Department

The core department, which occupies a corner in the side bay west of the crucible furnaces, as indicated in Fig. 12, is provided with the usual equipment, including a Whiting, five-drawer coke-fired oven. Adjacent to the core oven is a large mold drying oven shown at the right in Fig. 2. It is 22 feet long, 20 feet wide and 7 feet high inside and is equipped with a track and car for handling heavy molds. Also, the walls of the oven are provided with three rows of wide shelves for small molds. The roof is flat and consists of tile blocks supported between I-beams spaced on 15-inch centers. Both the drying oven and core oven are fired from a common pit in the rear.

For the convenience of the men a completely equipped locker and wash room, 18 feet square, has been partitioned off from the main foundry. It is situated in the southeast corner of the building adjacent to the superintendent's office, which is 9 x 18 feet.

The main office is in a separate building south of the foundry. This building also contains the pattern storage vault, Fig. 11. It is 100 feet long and 20 feet wide, equipped with 10 double steel racks containing six shelves each. The vault is lighted through the roof, cement tiles glazed with wire glass being used for the purpose. Behind the pattern storage vault is a small pattern shop 20 feet square. The flaskmakers' and carpenter shop is partitioned off from the southwest corner of the main foundry building. The buildings are brilliantly illuminated with enclosed arc lamps and there is also an abundant supply of compressed air available at all times.

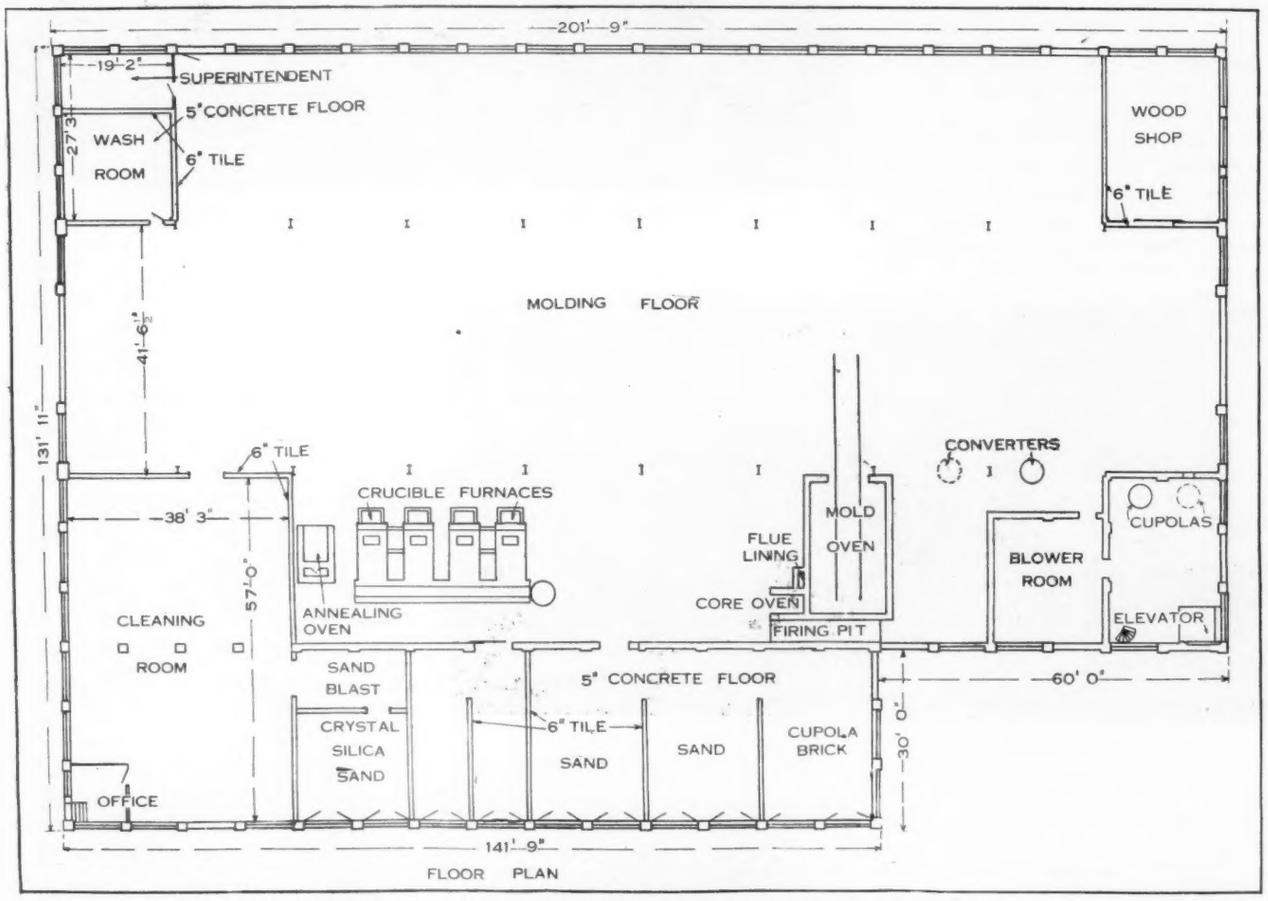


FIG. 12—PLAN SHOWING GENERAL ARRANGEMENT OF THE CHICAGO STEEL FOUNDRY CO.'S COMBINED CRUCIBLE AND CONVERTER STEEL PLANT

The Rockwell Furnace Co., New York City, will make an extensive installation of reel type core ovens in the plant of the Canadian Westinghouse Mfg. Co., Hamilton, Ont., Can.

British Methods for Testing Molding Sands*

Rational Analysis is Discussed and the Value of Microscopical Examinations is Pointed Out—A Few Peculiarities of the Molder

By Alfred B Searle

WHENEVER a material is used which occurs in a natural state, it is usually subject to variations in character which may utterly spoil it for the purposes for which it is employed. The sands used by molders ought, therefore, to be tested in some way in order to minimize the losses which would otherwise result from the use of unsuitable sand. The necessity for some form of testing is recognized in an indefinite manner by every molder, and some of the tests applied in the shops are of value, though very crude and limited in scope. On the other hand, molders have generally failed to recognize the necessity for more complete knowledge of the sands they use, and many of them are, in consequence, paying more dearly for their sands than would be the case if they were tested properly. One particularly striking example occurred recently in the experience of the writer, in which a firm was purchasing sand from 140 miles distance when a sand more suitable for its purpose, but of less attractive appearance, could be obtained from a pit close to the works. In this instance a certain amount of prejudice existed, as the foreman molder was accustomed to a particular sand and did not see fit to change when he entered the employment of another firm. It was only when the characteristics of the two sands had been closely compared that their practical identity was proved and the nearby sand was used with success on a commercial scale.

Idiosyncrasies of Molders

The lack of information on the subject of testing makes it difficult to lay down a complete series of tests, for the requirements of different shops differ very greatly and the idiosyncrasies of different molders must also be considered. For instance, in one shop in which the writer is interested, three different molders used three different sands, and could not, for a long time, be persuaded to change. Even that most cruel test of all—the secret substitution of one sand for another—failed to overcome the difficulty as soon as the substitution was discovered, though during the three months it remained unknown no noteworthy troubles occurred.

The chief measurable characteristics of molding sands are refractoriness, porosity, permeability, fineness and strength. It will be observed that these are all physical properties, yet they are to some extent, dependent upon the chemical composition of the sand, and this must, therefore, be taken into consideration.

Chemical Composition

To a large extent chemical composition has been misunderstood, and analyses of sands have been made on lines which are not to the best interests of the molder. For example, the composition of a typical molding sand will usually be reported as follows:

	Per cent.
Silica	84.13
Alumina	9.42
Iron oxide	4.41
Lime	1.73
Alkalies	0.31
Total	100.00

In the first place it will be observed that the analysis adds up to precisely 100, a feat of skill almost impossible even to the ablest analyst and an almost certain sign that some constituent has been estimated by difference. This is a convenient way of stating that the analyst has been too lazy, too busy, or too ill-paid to make a proper analysis, and has determined the silica, alumina, iron oxide and lime, and has then found that 0.31 per cent of material remains unaccounted for. He therefore describes this difference as alkalies, and soothes his conscience with the thought that so small a percentage of any ingredient can make no appreciable difference in the value of the sand. This method of working is all the more usual because the labor attending an actual determination of the alkalies is equal to that required for all other constituents put together.

For some purposes, such as glass-making, an accurate knowledge of the proportion of alkalies is unimportant providing that the sand is otherwise pure; but for molding, the presence of lime, magnesia and alkalies—even in small quantities—has a notable effect on the heat-resistance of the sand, and their proportions should be ascertained with great exactitude. It is, as a matter of fact, less important to know the proportion of silica than of alkalies, and if so complete an analysis cannot be obtained on account of the cost or labor involved, it is better to treat the sample with hydrofluoric acid until all the silica has been driven off and to analyze the residue, than it is to make a guess at the proportion of alkalies, as is so frequently done.

A further serious defect of the ordinary method of reporting the results of an analysis in the form given is that it does not give the information required by molders.

Sands are essentially composed of three groups of substances: Quartz, clay and other minerals. Of these the quartz is the main constituent, its grains being bound together by the clay; the other minerals may be regarded as impurities. The quartz, if pure, is composed entirely of silica, but all the silica in a sand is not in this form. Some of it occurs in combination with alumina in the form of clay and the remainder in combination with lime, magnesia, iron and alkalies forming other minerals, the nature of which must be determined.

Method of Rational Analysis

Many attempts have been made to resolve sands into their constituents, quartz, clay and other minerals, but no chemical method yet devised has proved satisfactory. Bischof Seger, some 30 years ago, devised what is known as a ***method of rational analysis,*** in which the material is treated with boiling sulphuric acid and then with caustic soda. These investigators thought that the clay alone would be disolved by this treatment, but it has since been proved conclusively that the method is quite unreliable except for relatively pure china clay—a material of little or no interest to molders.

If *rational analysis* gave correct results these would agree with the results of an ordinary or ultimate analysis which is known to be obtained by correct methods. In actual practice, however, the two results differ so large-

*Presented at the Cardiff convention of the British Foundrymen's Association.

ly that it is very unwise to place any reliance on the results of rational analysis.

Some idea of the mineralogical composition of a sand may be gained by assuming that the alkalies, lime and magnesia, are all in the form of felspar, and then calculating the proportion of alumina and silica corresponding to this assumed felspar. Any excess of alumina may then be calculated to clay (Al_2O_3. 2 SiO_2. 2 H_2O), the silica corresponding to this deducted from the silica not in the form of felspar, and the remaining silica may then be assumed to be quartz. This method gives results which are no less accurate than the *rational analysis,* but they are subject to the serious objection that felspars do not contain magnesia and that in some sands the bases are present as mica and other minerals. Hence, the only method which is at all reliable, consists in a careful microscopical examination of the sand and in deducing from this the proportion of the different minerals present. Needless to say, this is a very arduous task and one beyond the skill of any but an expert.

The basis and chief constituent of sand is one of several forms of silica. It is seldom pure in molding sands and the presence of iron oxide, lime and other substances materially detracts from its value. Broadly speaking, the more pure quartz a molding sand contains the higher will be its value.

"Other Minerals"

Other minerals is a large term, and includes the small grains of almost every kind of rock, but particularly of rocks of igneous origin. In molding sands it is extremely difficult to identify the various minerals present and this identification is, in consequence, seldom attempted.

There is, unfortunately, a strong tendency on the part of some foundrymen to assume what is convenient rather than to investigate whether such assumptions are correct. This is particularly noticeable when a discussion arises on the mineral constituents of sands. It is only misleading to assume that the greater part of *other minerals* in sand are composed of felspar, and a number of erroneous conclusions have in consequence, been made with regard to molding sands.

Comparisons of the proportion of alumina in various samples, though very common, are particularly misleading, as the alumina is a constituent of many minerals occurring in sands, and the extent to which it is present gives no idea whatever of the amount of the mineral of which it forms a part.

It is, in consequence of these difficulties, that the greatest caution is needed before an opinion as to a sand can be rightly expressed, and it is quite true to state that, at the present time, there is no simple means of ascertaining the true composition of a sand or loam; expert knowledge of micrography, as well as of analysis is essential.

Clay

Clay is an almost invariable constituent of British sands, although in some of them it must be present in very small proportions. Some idea of the amount may be gained by shaking up the sand with 20 times its weight of water in a tall glass cylinder and noting the amount of matter remaining in suspension after one minute. The test is vitiated by the extremely fine sand present, some of which will remain in suspension for an hour or more.

Table I.

Sieve.	Diameter of particles.	Nature.	Factor.
A On Sieve No. 1.....	Above 0.5 inch.....	Stones	Nil.
B Between Sieves Nos. 1 and 10..	Above 0.05 to 0.5 inch...	Gravel	0.27
C Between Sieves Nos. 10 and 50.	Above 0.01 to 0.05 inch..	Course sand	2.6
D Between Sieves Nos. 50 and 100	Above 0.005 to 0.01 inch.	Med'm sand	13.2
E Between Sieves Nos. 100 and 200	Above 0.0025 to 0.005 inch	Fine sand	22.6
F Between Sieves Nos. 200 and washing	Above 0.0004 to 0.0025 inch..	Silt	53.9
G Washed out by a stream 0.43 inch per minute.....	Below 0.0004 inch.....	Clay & dust	359.0

One of the most valuable characteristics of clays is their plasticity, but, unfortunately, no one has yet succeeded in measuring this property in a really satisfactory manner when the clay is mixed with a large proportion of sand. So little is known of the plasticity that it is by no means clear that it has any connection whatever with the composition of the material. Two clays may have the same chemical composition, yet their relative plasticities may be widely different.

It was thought at one time that the power possessed by clay of binding or absorbing certain aniline dyes might provide a means for determining the proportion of clay present, but more careful experiments have shown that this method gives very irregular results with different sands, though useful in checking the clay-content of different batches of the same sand.

The writer has examined many sands for various purposes and has found that a carefully arranged system of washing is the simplest means of separating the clay from the other constituents. This may be most readily carried out by stirring a convenient quantity of sand with water in a small tank containing paddles. The overflow from this tank is received at the bottom of a larger conical tube in which the water flows at the rate of 0.43 inch per minute. This is sufficient to carry away all the clay, together with a little of the finest sand. The product is never pure, and usually contains half its weight of sand, but this is the purest product at present obtainable. To obtain the best results very small quantities of sand must be employed, and a Schoene's elutriating funnel used. Various processes of sedimentation have also been tried, but are less satisfactory. Unfortunately, no means of definitely separating the extremely fine grains of sand from those of the clay have yet been discovered, as their specific gravities are almost identical, and no chemical reagent is known which will attack either the clay or the sand without interfering with the other.

Color

The color of molding sands is unimportant, except as a rough guide to the form in which the iron is present, red sands indicating free ferric oxide. This oxide is understood to assist in putting a good skin on castings, but it has the serious disadvantage of being reduced by the coal or coke dust mixed with the sand, thereby forming fusible ferrous silicates which bind the sand grains into lumps, and, when sufficient of these are present, rendering it dead and useless. Various oxidants are used to prevent the occurrence of this reduction or to revive the sand in which it occurs; it is, however, better to use sand containing less iron oxide and never to use that which contains more than 5 or 6 per cent.

Refractoriness

Refractoriness or resistance to heat in a sand depends on the proportion of *other minerals* present, and on the fineness of the grains of quartz, etc. Sand is usually so refractory that a direct test of its heat-resisting powers is of little value. The writer prefers to separate the sand into two portions by means of a No. 150 or 200 sieve, and to test the heat-resistance of the material which passes through the sieve. In this way, the coarser, refractory particles are removed, and the finer and more fusible ones are isolated, so that their presence and effects are more marked. As it is not the absolute refractoriness that is required, but only the tendency of the

sand to vitrify or fuse in places, this separation of the more fusible constituents is of value.

The fine material, or if preferred the original sample is mixed with a little dextrine and water and is molded into a small pyramid about 2½ inches high with a triangular base with ⅝-inch sides. This pyramid is heated in a test furnace along with Seger cones and the number of the latter corresponding in behavior with the test piece is taken as the refractoriness of the sample.

Porosity and Permeability

The porosity of a molding sand is of smaller importance than is generally supposed. It is not the number or size of the pore spaces between the solid grains of the sand, as received, that is important, but the facilities for the escape of gases offered by the sand when made into a mold. A sample of sand may be very porous when placed in a test glass or cup, but it may be very unsuitable for molding because, when rammed to form a mold, the gases cannot escape. The writer has made numerous comparisons, but has been unable to trace any direct connection between the porosity of sands as received and their suitability for molding. He, therefore, regards a porosity test as of minor importance.

The permeability to gases of a mold made of sand, on the contrary, is of great importance, and no tests of molding sands can be complete without it. Unless the gases formed during casting can escape with sufficient rapidity, scabs are formed and defective castings are produced. The permeability of a mold depends partly on the shape of the casting and on the skill of the molder as well as on the sand mixture used, and in any test of this property due importance must be attached to the personal element. The writer has obtained the best results in the following manner:

A mold case is used which consists of a circular metal box, 3 inches diameter and 1¼ inches deep, with the bottom cut out and replaced by wire gauze of any convenient mesh. On the bottom of this case a sheet of thin porous blotting-paper is laid and the case is filled with the sand to be tested, care being taken to ram it in a manner as similar as possible to that employed when an ordinary casting is to be made. The sand or sand mixture should be precisely 1 inch thick. In order to preserve the conditions of normal ramming the writer frequently places the empty test case in a larger mold in course of formation, and removes it when filled, the space left in the larger mold being afterwards repaired. The case is filled by laying on a second sheet of paper and by inserting a flanged pipe, the whole being then clamped firmly, but without breaking the structure of the sand. Water is poured into the flanged tube to a height of 40 inches and the appliance is suspended above a glass receiver or measure. The time taken for 100 c.c. of water to flow through the sand into the receiver is a measure of its permeability. In exact experiments the level of the water in the flanged tube must be kept constant.

If care is taken in making the test, results from similar sands are very constant, but test blocks made by different molders differ so greatly that no comparison is possible. Hence in testing fresh deliveries of sand it is important that all the test pieces shall be made by the same molder. At the present stage this test is of value in works for the manager's own use, but not for comparison with the results obtained by others; the difference caused by unconscious variations in manipulation are too great. In a modification of this test the writer endeavored to substitute air in place of water, but the variations in the amount of air penetrating through the same block at different times as well as with different tests of the same sand made the use of air appear to be impracticable. Further experiments are, however, being made in this direction.

Fineness

The fineness or size of grains of sands used for molding has never been standardized and equally good results have been obtained with sand of most divergent characteristics in this respect. The writer, for more than 10 years, has used a series of sieves with 10, 25, 50, 100 and 200 holes per linear inch.

The sand is mixed with water, well shaken for half an hour or more in a mechanical agitator and then is run onto each of the sieves in turn. Each sieve is then washed with a powerful stream of water so as to insure that all the sand finer than the mesh will run onto the next finer sieve. The contents of the various sieves are then dried and weighed. The material which passes through the finest sieve contains all the clay together with an equal weight, or more, of sand. This mixture is placed in a Schoene's elutriating tube and water is passed through it at the rate of 0.43 inch per minute. In this way a further portion of very fine sand remains in the vessel, the clay with some sand being washed out by the water. This clayey portion is collected, dried and analyzed; its composition will give a fair idea of the proportion of clay present.

Surface Factor

The surface factor is found by multiplying the weight of each fraction separated in this manner by an appropriate factor and adding all these numerical products together. The factors for multiplying are shown in Table I.

If the weight of each fraction be represented by the letters in the first column in Table I, the surface is

0.27B + 2.6C + 13.2D + 22.6E + 53.9F + 359G.

The finer the sand, the higher will be the surface factor. As the factor for stones is *nil* the weight of stones present does not enter into the calculation except insofar as it reduces the total forming the surface factor.

Table II.

Sand.	A.	B.	C.	D.	E.	F.	G.	Surface factor.
Medium Erith	....	0.03	1.19	0.34	42.74	28.52	27.17	12,205
Fine Mansfield	....	....	1.50	3.92	40.63	31.73	22.21	10,657
Coarse Mansfield	0.01	0.74	3.36	18.42	67.17	6.49	3.81	3,497
Stourbridge	....	0.22	5.36	18.93	54.76	14.64	6.08	4,472

The use of this factor in comparing several well-known molding sands is exemplified in Table II, in which the letters indicate the proportion of each of the grades.

By means of this surface factor a single expression is used for the fineness of a sample of sand and a ready method of comparison is obtained. The difference in texture between the fine and coarse Mansfield sands is well shown in the table, the Erith sand corresponding with the former and the Stourbridge with the latter.

The sharpness of sand cannot be expressed numerically, but a careful microscopical examination will usually enable the relative angularity of the grains of two samples to be determined in a few minutes.

Strength

The strength of sand when in the form of a mold is another property for which no satisfactory method of measurement has been found. The measurement of the tensile strength of test pieces made with fixed weights of sand, water, and dextrine has not proved satisfactory, and the sand, as actually

used by molders, has so little compressive or tensile strength that the errors of experiment are so great as to destroy the value of the results. The writer has ascertained the maximum weight which can be carried by a cube of sand with 2-inch sides, the weight being applied in the form of a light aluminum cylinder with a large base. Water or mercury is run into the cylinder until the cube of sand loses its shape. So far the results, though interesting, are far from constant with different batches of the same sand, though consecutive cubes made from a small sample yield constant results.

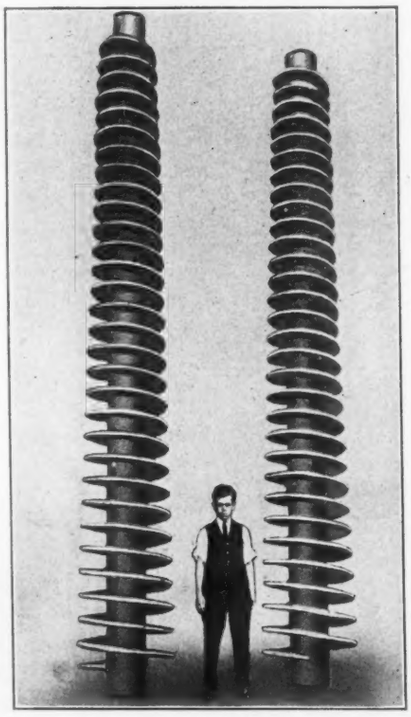
Dead Sand

Dead sand is that which has been mixed with coal dust, has been used a number of times by the molders and has lost its valuable properties. Dead sand is deficient in plastic clay, as may readily be seen by examining the finest portions removable from the material by a slow stream of water. It also contains a larger proportion of sand grains which have been fastened together by the fusible silicates produced by the reaction of the coal dust on the iron oxide and silica in the material. Dead sand has a very low surface factor—in the specimens examined by the writer this varied from 437 to 1,025—and as it does not pay to grind it and so increase the surface factor, dead sand can only be used to a very limited extent along with new sand.

In spite of the difficulties experienced in testing sands and in formulating satisfactory conclusions from the results of such tests, their value is unquestionable, and as users of molding sands accustom themselves more and more to the study of the properties of the sands they use, the greater will be the progress made in obtaining satisfactory castings. In Germany, where the use of artificial mixtures of various sands is common, the writer has found an increasing tendency to detailed standardization of the different sands employed; in this country, on the contrary, molders are blessed with natural sands of sufficiently suitable composition and physical properties, and there is less inducement to improve these natural materials. Nevertheless, a careful study of the tests suggested, combined with that of actual castings produced from known sands and mixtures, has convinced the writer that the use of such improved sands is one of the great needs of the industry at the present time. The chief difficulty is that the most effective tests are beyond the capability of the ordinary foreman, while those who have the ability for carrying them out do not have access to a sufficient number of foundries to be able to draw general conclusions.

Large Cast Steel Screws

In the accompanying illustration are shown two cast steel screws for use in pressing oil from fish. The largest is 19 feet, 4 inches long, has 30 flights which range from 29½ inches in diameter at the larger end to 20 inches at the smaller end, and has a six-inch core extending the entire length of the screw. The larger casting weighs 7,590 pounds. Both were poured in single



TWO LARGE CAST STEEL SCREWS

molds through one gate from steel made in a 30-ton, acid open-hearth furnace. They were cast in iron flasks and were molded from a split pattern, ordinary facing sand having been used. The castings were annealed before being shipped. The metal used had a tensile strength of 71,500 pounds per square inch, an elongation of 28 per cent and a reduction of area of 44.9 per cent, while a bar, ½ x 1 inch, was bent 180 degrees without fracture. These castings were produced at the plant of the Penn Steel Castings Co., Chester, Pa.

The General Electric Co., Erie, Pa., is installing a car type heat treating furnace, built by the Rockwell Furnace Co., New York City. The latter company also is making an extensive installation of reel type core ovens at the plant of the Canadian Westinghouse Mfg. Co., Hamilton, Ont., Canada.

Filling Shrink-Holes in Cast Aluminum

By H. N. Tuttle

On page 193 of the May issue of THE FOUNDRY an alloy was discussed which can be used for filling shrink-holes in castings. We use the following alloy or solder, with excellent success: Aluminum, one part; zinc, 11 parts; tin, 29 parts, and phosphor-tin, one part. These proportions are measured by weight and are melted in the order named. Immediately after the aluminum castings are shaken-out, they are examined for shrink-holes and if any imperfections are noted, a stick of the alloy is rubbed into the shrink-hole until it is filled with the solder which melts at a slightly higher temperature than common solder. While the solder is still liquid, the surface of the casting underneath the solder, where the two metals are to be united, is scraped with any suitable tool, but care must be exercised that the surface being scraped in this way is entirely covered with the molten alloy to exclude the air, thereby preventing the formation of aluminum oxide. After the surface is nicely tinned, the casting is not disturbed until it has cooled sufficiently to permit the solder to solidify. We have filled hundreds of shrink-holes and have soldered lugs and other additions onto castings with this alloy, but have never had any difficulty with the joints after they have been made in this way. When using the solder in the usual way, it is necessary to tin the surface to be soldered, similar to the manner of tinning cast iron, by continual rubbing with the copper or by heating with a blow torch and by scraping as described for filling shrink-holes. If two pieces of aluminum are to be soldered together, both surfaces should be tinned and the pieces should be sweat together, as aluminum solder will not flow in a joint.

Foundry Nails

The Merwin Mfg. Co., Erie, Pa., makes a complete line of large-head foundry nails. These special nails effect a large saving over the ordinary wire nail frequently employed in foundry work. Not only is a smaller number of the nails required, owing to the large flat head, but the number of nails per keg of a certain size is greater than that of the ordinary nails, owing to the light gage of wire from which these foundry nails are made. Any special size and length of nail to meet the requirements of the user can be furnished. A circular has been issued by this company which shows the percentage of gain in count and area of head as compared with the ordinary wire nail.

How to Mold a Small But Intricate Casting

The Pattern is Molded in a Five-Part Flask and a Large Number of Irregularly-Shaped Cores Are Employed

IN MOST foundries the proprietor takes considerable pride in pointing out some large casting and complacently remarking, "This is the kind of work we produce." He will tell you in detail how many days it took to make the casting, how many ladles of iron went into it, and how the mold was made. To represent an intricate and complicated piece of work, however, a casting need not be large, nor even fair-sized, for the production of a small casting often presents quite as difficult a problem as that of a large piece. The making of molds for small castings often entails the careful handling and placing of numerous, fragile, dry-sand cores, the use of several cheeks, and the reinforcing, venting and skin-drying of exceedingly delicate portions of the mold. In fact, it may be said that two distinct kinds of skill are employed in the production of large and small castings.

At *B*, Fig. 4, is shown an interesting casting of the small type, manufactured at the plant of the Hudson Foundry Co., Jersey City, N. J. These castings are produced regularly at this shop for use as burners in the heating and lighting torches manufactured by the Wells Light Mfg. Co., 44-46 Washington street, New York City. Since they must be carefully cast to insure a free and unobstructed passage for the proper circulation of the air and oil spray, the main feature in setting up the molds is the placing of the cores. Because of the peculiar construction of these burners, it is necessary that they be perfectly cast, since it is impossible to remove obstructions from their interiors after they have been made.

The Pattern.

The pattern for the burner, *A*, Fig. 4, is in four parts and is rammed in an iron flask, 10 x 10½ inches, and 15 inches high. This flask consists of cope, drag and three cheeks. The drag is rammed on a sand and plaster of Paris match plate, after which the cheeks and the cope are made. The sprue extends down to the drag portion of the mold, in which the gate is cut. The mold is also provided with a riser. A large quantity of nails and wire rods is also employed in this mold, as the sand, in some portions, is but little over ⅛ inch in thickness.

For the purpose of skin-drying, the Hudson company resorts to the use of a hot cast iron plate instead of the customary oil burning torch. This plate, shown in Figs. 2 and 3, is heated to the desired degree, after which it is placed directly over a portion of the mold before the latter has been cored. Thus the drying process takes a somewhat longer time than is usual, but the company claims it derives better results by following this method.

When setting the cores in the mold, the drag is first embedded on the floor, after which the coring-up process proceeds. The two cores which are placed between the first and second cheeks and between the first cheek and the drag are quite similar, having a cylindrical cross-section, ½ inch in diameter; they are connected at the four corners by means of cylindrical projections from one core which fit into corresponding cup-like depressions in the other core, thereby insuring perfect joints. These cores are thoroughly vented. The core which is placed in the second cheek is called the *bottle-core*. This is provided with a vent opening at the bottom, which is so located that it meets the opening of a simi-

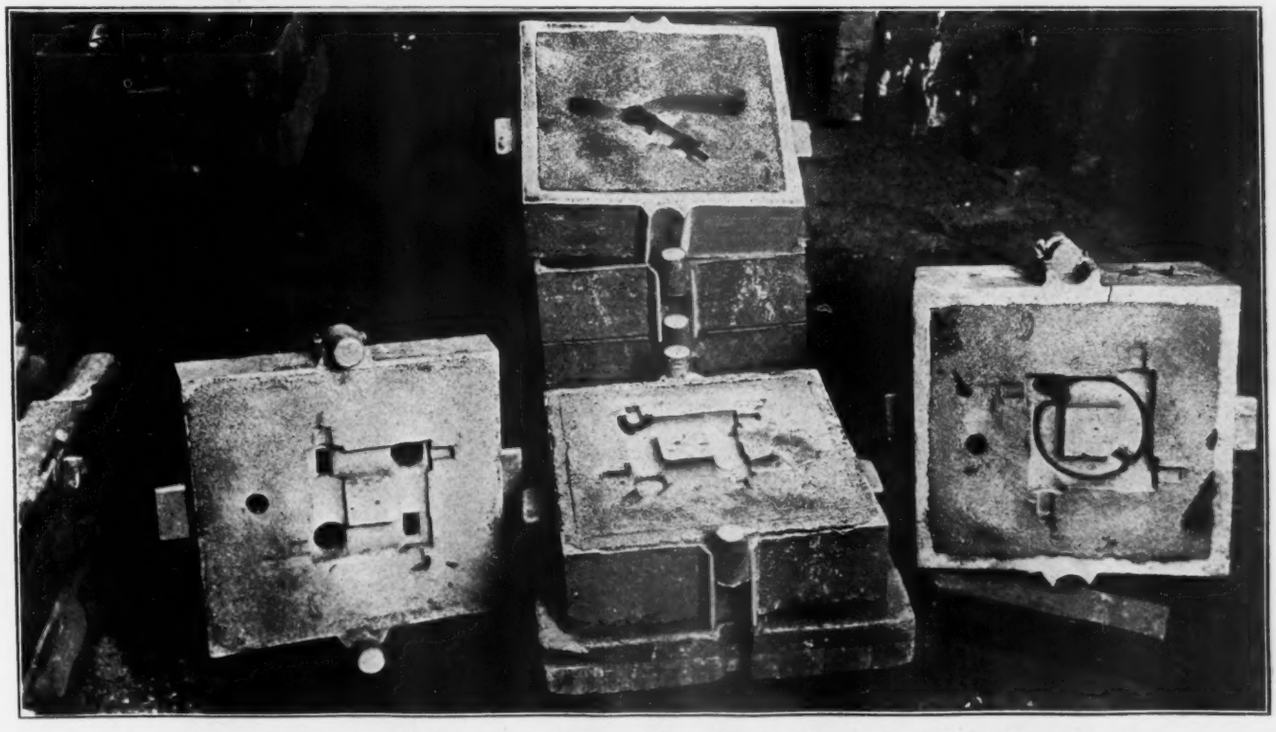


FIG. 1—VARIOUS PARTS OF THE BURNER MOLD, SHOWING THE COPE, DRAG AND CHEEKS

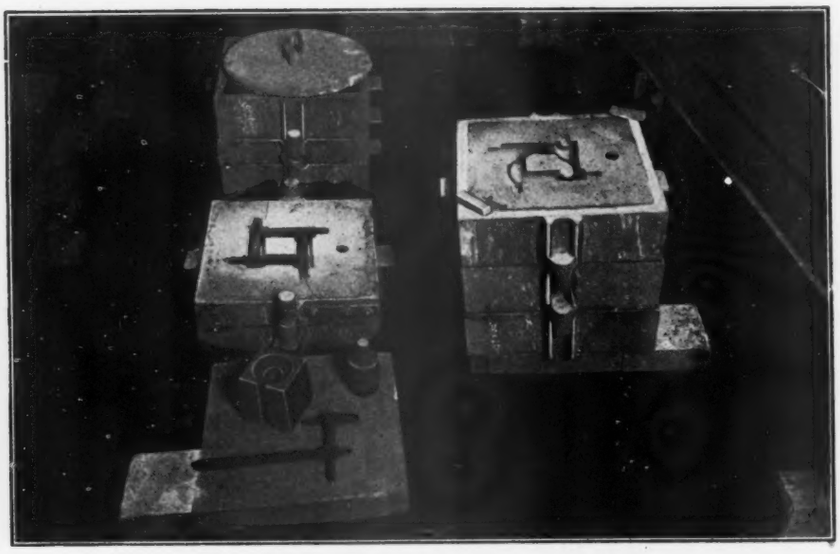


FIG. 2—SETTING THE CORES IN THE MOLD

lar vent-hole in the imprint in the cheek below. In the third cheek is placed a core which is approximately square; it serves partly as a core and partly as a portion of the cheek. In this cheek is placed also a core of cylindrical cross-section which is turned at a right angle. Above this is placed the cope. After closing, the mold is weighted down for pouring. Ordinary, fine-grained beach sand is used for making these cores, linseed oil being used as a binder. The cores are strengthened by the use of fine wire rods. The iron mixture used consists of No. 1X carbon, 75 per cent, and machinery scrap, 25 per cent. When cleaned, the casting weighs approximately 10 pounds.

F. H. and T. W. Lewis, who have been proprietors of the Hudson Foundry Co. for the past four years, were formerly connected with the A. A. Griffing Co., Jersey City. The former was assistant superintendent of that plant for 19 years and superintendent for 15 years. T. W. Lewis was foreman of the Griffing company's pattern shop for about 17 years. The Hudson Foundry Co., in addition to its jobbing work, has arranged to furnish all the repair castings for the line of boilers and radiators formerly made by the A. A. Griffing Co.

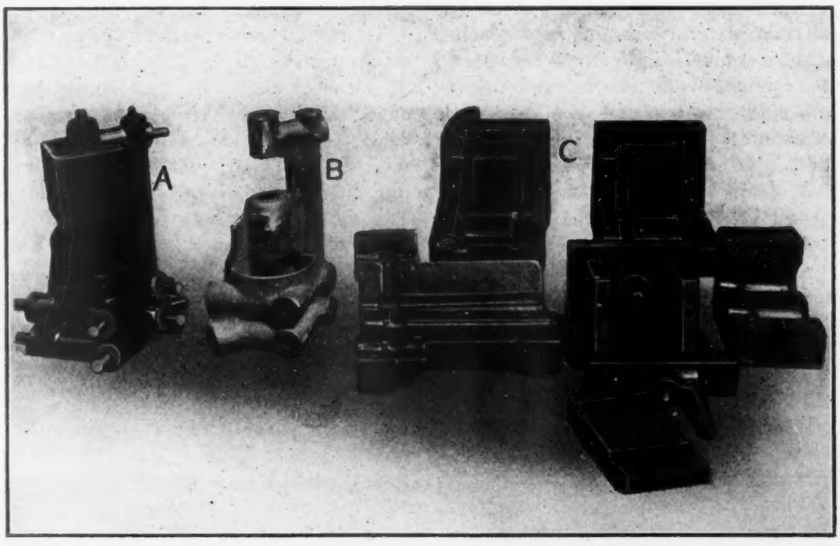


FIG. 4—PATTERN, CASTING AND THE METAL BOXES FOR MAKING THE CORES

FIG. 3—CORES SET IN THE MOLD READY FOR CLOSING. THE HOT PLATE USED FOR SKIN-DRYING IS SHOWN IN THE BACKGROUND

Arsenic

Arsenic is a brittle solid, of a steel gray color and metallic luster. Its specific gravity is 5.96, and it possesses many points of resemblance to phosphorus and is also allied to antimony. Arsenic is obtained by distillation from its ore and is extensively mined in Virginia. The rock is first crushed, after which it is calcined in a rotary calciner, which consists of an iron tube, 50 feet long by 6 feet in diameter. At one end of the tube is a furnace, which is fired with wood and the calciner is lined with firebrick for two-thirds of its length from the furnace end. The charge of ore is heated in the calciner, to a temperature of about 800 degrees Fahr. and the gases are driven off through the calciner into a flue which is over 300 feet long and about 7½ feet in diameter. It is provided with baffles at intervals of 5 feet. These baffles settle the arsenious oxide from the escaping gas, by causing it to alternately contract and expand, as it passes through the flue on its way to the stack. The arsenious oxide is a gray powder and is contaminated with impurities which are removed by refining in a reverberatory furnace. The crude

arsenious oxide is volatilized and leaves the sulphur and other impurities behind as a residue. The gas is passed through a flue similar to the one used in the case of the crude product, which is interposed between the furnace and the stack. After refining, the arsenic is collected as a white powder, containing sometimes over 99 per cent of arsenious oxide. The metal is obtained from the oxide by heating it with charcoal in covered crucibles.

Steel Foundry Sand Grinding Machine

A feature of no little importance in a steel foundry is the method of mixing and grinding the sand before it is delivered to the molding floors, and for this purpose various types of pan grinding and mixing machines have been designed. In the accompanying illustrations is shown a pan grinding machine specially constructed for its own use by the Penn Steel Castings & Machine Co., Chester, Pa.

This machine differs from the usual type of pan grinder in that the pan revolves, whereas in other types of grinding machines the rolls revolve around the bottom of the pan. The mill is built on a solid concrete bed and is constructed entirely of steel. The pan, which is 8 feet in diameter, is supported by six wheels with tapering treads. These revolve on a circular steel rail having a tapered surface to correspond; the rail is firmly embedded in concrete. The pan is operated by a 35-horsepower, direct current motor which, by means of a pinion at one end of the gear-driven shaft, meshes with a circular rack securely bolted to the lower rim of the pan.

The two grinding wheels, which are revolved by contact with the pan, are 4½ feet in diameter. The treads or tires are 14 inches wide and are made of hardened steel; when worn they may be replaced without removing the wheels or otherwise dismantling the machine. The thickness of these tires is 3 inches. The grinding wheels are centered on a heavy steel shaft which is supported by a housing at each end. As the depth of the sand in the pan varies constantly, the shaft is alternately raised and lowered. Therefore, the bearings in the housings have been so designed that they may be moved up and down in grooves, to follow the vertical movement of the shaft.

To constantly deliver the sand directly under the wheels, the pan is provided with three stationary, cast steel sweepers which are attached to a framework of steel shafting resting on the guard frame. The unloading of the sand is accomplished by lowering a scoop into the pan, which diverts the sand out of the pan and into a steel box, which is placed in a pit immediately in front of the machine. This box is 4 x 5 feet and 2 feet deep, having a capacity of 1½ tons of sand. When filled, it is delivered to the molding floors by the electric traveling crane. The scoop is counterweighted at one end.

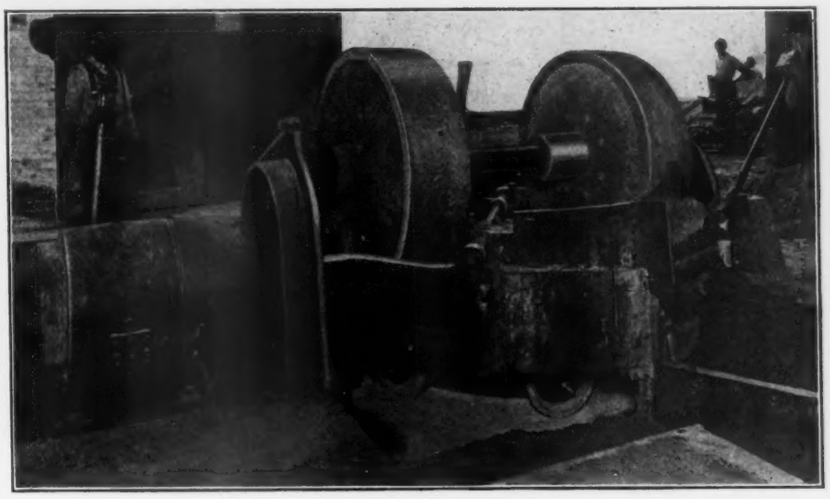


FIG. 2—MOTOR DRIVE FOR OPERATING THE MACHINE AND METHOD OF DISCHARGING THE SAND

The machine operates continuously, producing approximately 30 tons of thoroughly mixed and ground sand in 10 hours. It is operated by three men and has been in constant use for about four months.

In order that the workmen may not be exposed to injury by the revolving pan, the rim has been enclosed in a substantial frame which is bolted to the housings at each end. The motor also is covered with a hood to protect it from sand and dust. This machine was designed by Walter S. Bickley, president and general manager of the Penn Steel Castings & Machine Co.

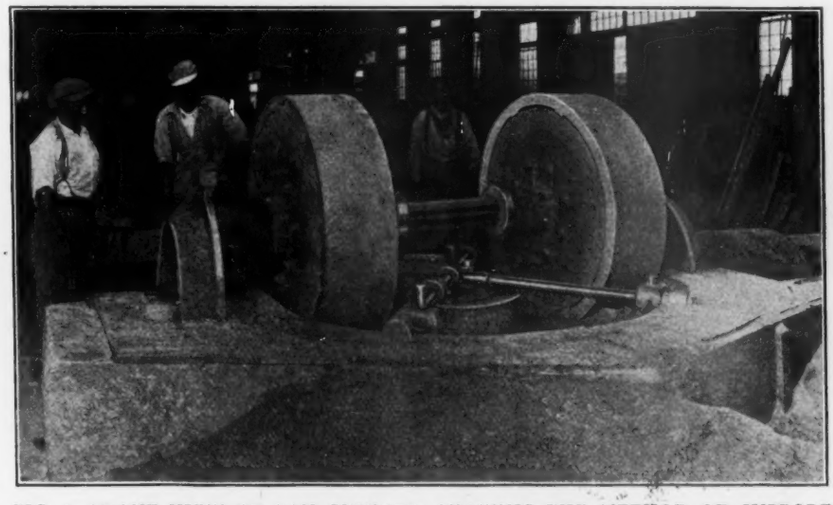


FIG. 1—FRONT VIEW OF PAN GRINDER, SHOWING THE METHOD OF SUPPORTING THE SWEEPERS AND THE HOUSINGS FOR THE ROLL SHAFT

Argilite

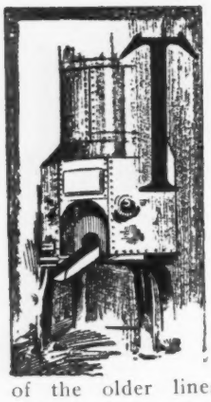
Argilite is the name of a new aluminum alloy recently invented by Prof. Gaston Jacquier, which is claimed to be suitable for the manufacture of tubes, pipes and armor plate. The new alloy possesses a low specific gravity, is hard and resistive to pressure and corrosive action. Its composition is stated to be as follows: Aluminum, 90 per cent; bismuth, 2 per cent; copper, 6 per cent, and silicon, 2 per cent.

Scientific Management of a Foundry Cupola

The Report of An Interesting Series of Tests Which Was Conducted to Ascertain the Thermal Efficiency of the Iron Melting Furnace

By Edward K Hammond

The investigation of the thermal efficiency of the cupola reported in this article is probably the first that was ever undertaken on so comprehensive a scale. The conclusions arrived at are startling, as they indicate that the thermal efficiency of the cupola tested is only 47.34 per cent. To secure the maximum efficiency in operating an iron melting furnace the heat should be arranged to run for the longest possible period. A great loss of efficiency also was noted when the level of the charge in the furnace was permitted to drop. The data on the results of remelting iron are interesting, as they show decreases in the percentages of graphitic carbon, silicon, manganese and phosphorus and increases in the sulphur and combined carbon.



THE introduction of scientific methods of management has been a benefit to many industries, owing to improvements in the quality of their products and to increased efficiency which has been made possible. This is particularly true of the older lines of manufacture, where methods have been developed gradually from the unguided experience of several generations. The foundry trade was in exactly this condition before the application of chemistry to the industry, which occurred about 50 years ago. Although iron founding is one of the most ancient of the industries, little accurate information concerning the principles which govern the operation of a melting furnace was available until they were explained by the chemist.

Great improvements have followed the advent of the chemist in the foundry. These improvements have been the result of superior control that is obtained by the use of scientific methods of management and are not due to any changes in the fundamental principles upon which the industry is based. From the foregoing, we are able to develop an accurate definition of scientific management by stating that it consists of adding to the original common-sense methods of conducting the industry, a superior control over product and efficiency which is secured by the assistance of scientific men and their methods.

With the view of studying the conditions which must be fulfilled to secure a high degree of efficiency in the operation of a foundry cupola, the author recently conducted a series of tests with a widely used type of melting furnace. Information was sought along two distinct lines, as follows:

First, to account, as completely as possible, for all of the heat supplied to the furnace and to try to curtail needless losses in thermal efficiency.

Second, to secure data that would permit a study to be made of the changes undergone by the iron during the melting process.

To account for all of the heat supplied to the cupola, complete data on the following furnace operations were required:

1.—The weight of all materials charged into the furnace and of the resulting castings, slag, unburned coke and scrap iron.

2.—The amount of air supplied to the furnace in the blast.

3.—The temperature of the molten iron tapped from the furnace and of the gases discharged from the stack.

4.—The chemical composition of the furnace gases, and of the iron before and after melting.

How the Information Was Obtained.

Taking this subdivision of the required information as a basis, a brief description of the method of procedure that was followed and of the apparatus used in securing the necessary data will be given before entering upon a discussion of the results that were obtained.

A platform scale, accurate to 1-10 pound, was used to weigh the different constituents of the furnace charge and product. This scale was placed on the charging floor, where the coke, iron, and limestone were weighed before being charged into the cupola. After the heat was completed, all of the castings were carefully cleaned and weighed. The slag, iron, and un-

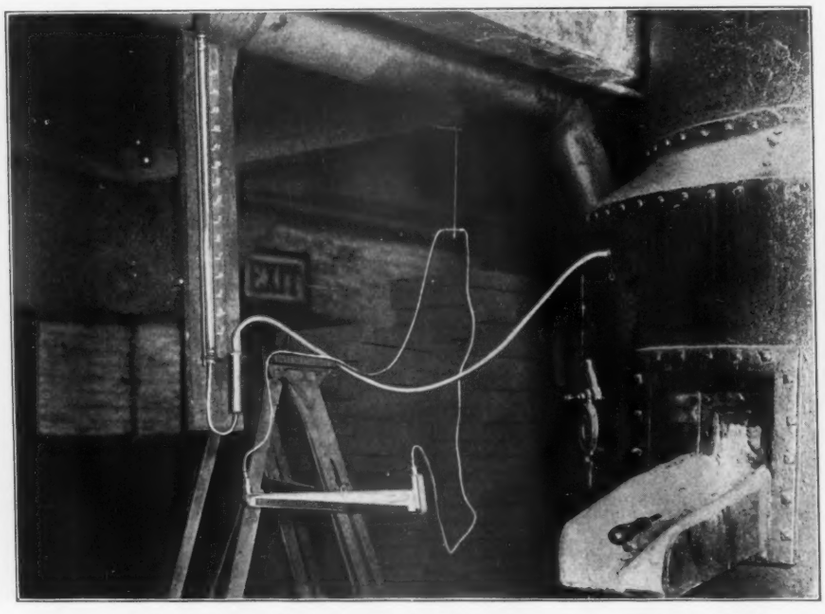


FIG. 1—PITOT METER AND DRAFT GAGE USED TO MEASURE VOLUME OF BLAST SUPPLIED TO THE FURNACE. MANOMETER USED TO MEASURE BLAST PRESSURE

burned coke dropped from the furnace were quenched by turning the hose on them; this refuse was then separated and the different materials weighed.

To determine the amount of air in the blast supplied to the furnace, it was necessary to make two measurements. First, the total pressure of the air in the blast pipe. Second, the pressure that is due entirely to the compression of the blast. The former is the pressure that is due to the sum of the compression and the velocity of the blast and is shown as the dynamic head; the pressure due solely to the compression of the blast is called the static head.

Measuring the Blast Pressure

For making these measurements of the blast pressures, a Pitot meter was used in connection with an Ellison draft gage, as shown in Fig. 1. The Pitot meter consists of two brass tubes of small bore, which are secured in the blast pipe by a threaded fixture. The end of one of these tubes is bent at right angles, so that the opening faces against the direction of flow in the blast pipe. The pressure of the blast entering this tube is the one referred to as the dynamic head. The opening in the second tube of the Pitot meter is set at right angles to the direction of flow of the blast, and the pressure of the air entering this tube is the one referred to as the static head.

It is a well-known fact that the velocity of flow in a pipe varies according to the distance from the center, and that there is a point where the rate of travel represents the mean velocity. The distance of this point from the center of the pipe is known as the mean radius, and in order to secure the required average rate at which the blast is moving, the openings of the tubes of the Pitot meter must be set at the extremity of this mean radius.

FIG. 3—METHOD OF TAKING TEMPERATURE OF IRON WITH RADIATION PYROMETER

Connecting the Meter and Gage

The two outer ends of the Pitot meter tubes were connected with the ends of the tube on the Ellison draft gage by pieces of rubber tubing, as shown in Fig. 1. The tube which receives the dynamic head was connected to the lower end of the draft gage tube and opposed the static head, which was effective at the opposite end. The dynamic head being the greater, causes a displacement of the fluid in the draft gage tube, the amount of this displacement being read on a scale which is graduated to read directly in inches of water, and indicates the difference between the dynamic head and the static head. This difference represents the velocity head, which is required to calculate the volume of air supplied to the furnace in the blast. The relation between these three pressures is indicated by the following equation:

Velocity head=Dynamic head—static head.

Owing to the very gradual rise of the inclined tube of the draft gage, it has been possible to graduate the scale to read differences of 1/100 inch of water between the dynamic head and the static head. In using the draft gage, it is important to have it set exactly level, a spirit level being provided on the instrument for this purpose.

FIG. 2—ARRANGEMENT OF PYROMETER USED TO MEASURE TEMPERATURE OF FURNACE GASES

Draft Gage Readings

In conducting the test, readings of the draft gage were taken at intervals of three minutes during the run, and from the average value of the velocity head of the blast secured in this way, and the known diameter of the pipe, the volume delivered to the furnace during the test was calculated. In order to obtain the weight of the air constituting this blast, it is necessary to know its pressure. This data is secured from the difference be-

tween the level of the water in the two arms of the U-tube shown mounted on a board in Fig. 1; this U-tube is connected with the blast chamber in the furnace by a piece of rubber tubing.

The temperature of the gases discharged from the cupola was taken at intervals of three minutes by a Thwing electrical pyrometer. The principle on which this instrument operates depends upon the fact that when the union of two different metals is heated, an electro-motive force is set up. In the Thwing pyrometer, the union consists of two wires of platinum and rhodium; these metals are chosen because they are not easily oxidized. In the type of instrument used, the couple is enclosed in a porcelain tube which is inserted through a hole in the wall of the furnace above the charging door, as shown in Fig. 2. The ends of the platinum and rhodium wires are connected in series with a mili-volt meter, which is graduated to read temperatures directly in degrees Fahr. As the electro-motive force produced is proportional to the temperature to which the union of the platinum and rhodium wires is heated, the instrument records the fluctuations of the temperature of the gases leaving the furnace. The end of the pyrometer and the electrical connections leading to the recording instrument are illustrated in Fig. 2.

Using the Pyrometer

The same type of pyrometer was used to take the temperature of the molten metal every time the furnace was tapped. The design of the instrument used for this purpose is slightly different from the one described. In this case, the platinum-rhodium union is set in a metal tube of larger bore than the porcelain tube on the pyrometer used to measure the gas temperatures.

In using the instrument to determine the temperature of the metal flowing from the tap hole of the furnace, the union of the platinum and rhodium wires, which is located at the end of the tube, is held at a distance of approximately two feet from the molten metal. The temperature of the union is thus raised to the radiation temperature of the metal, this temperature being indicated by the instrument. This radiation temperature must then be multiplied by 1.46 to obtain the actual temperature of the molten metal. The method of using this pyrometer is shown in Fig. 3.

To ascertain the composition of the gases discharged from the furnace, the apparatus shown in Fig. 4 was used for taking samples. It consists of a small pump that draws the gas through a hole in the wall of the furnace and discharges it into a bottle filled with water. As the gas is forced into this bottle, the water is displaced through a second tube which extends almost to the bottom on the inside, and when practically all of the water has been displaced in this way, the two openings are sealed with pinch-clamps. The gas samples taken in this way are analyzed according to the customary methods used for flue-gases. Analyses were also made of the following materials: The coke and its ash; limestone, slag

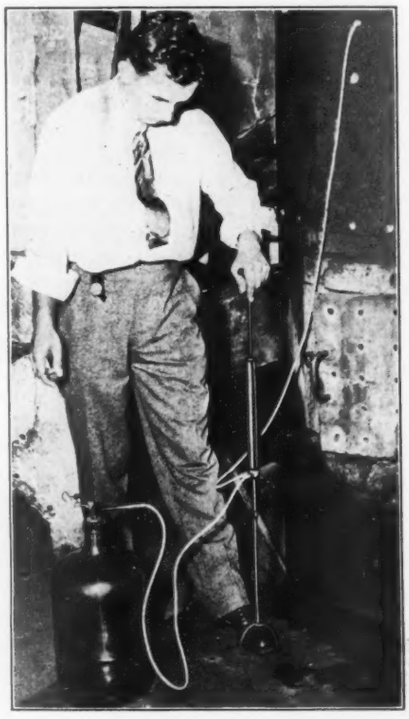


FIG. 4 — APPARATUS USED TO TAKE SAMPLES OF FURNACE GASES FOR ANALYSIS

and the scrap and pig iron used in the charge and the castings produced. A calorific test of the coke was also made, a Mahler bomb calorimeter having been used for this purpose.

The following data were taken during the course of the heat which will be discussed in this article:

The heat lasted for 67 minutes. The temperature of the gases escaping from the furnace at the time the blast was turned on was 311 degrees Fahr.; the highest temperature of the gases was 2,333 degrees Fahr.; this temperature having been reached at the time the bottom was dropped. The average temperature of the gases was 1,472 degrees Fahr. The average temperature of the metal tapped from the furnace was 3,452 degrees Fahr.

The charge for the furnace consisted of:

	Pounds.
Coke	528
Pig iron	800
Scrap iron	1,600
Limestone	154

The arrangement of the charge was as follows:

	Pounds.
Bed charge of coke	299
Scrap iron	800
Coke	49
Scrap iron	230
Pig iron	200
Limestone	40
Scrap iron	200
Coke	60
Pig iron	200
Limestone	40
Coke	60
Scrap iron	200
Pig iron	200
Limestone	40
Coke	60
Scrap iron	200
Pig iron	200
Limestone	34

The refuse dropped from the furnace after the heat was completed, contained:

	Pounds.
Slag	263
Unburned coke	117

The average pressure of the blast, as recorded by the manometer shown in Fig. 1, was 4.5 inches of water. The average value of the velocity head, obtained by means of the Pitot meter and draft gage was 0.81 inch of water which is equal to 56.5 feet of air. The mean radius of the discharge orifice of the blast pipe was 3 inches.

The results of the analyses made of the constituents of the furnace charge and of the resulting products are given in Table I.

The composition of the metal constituting the furnace charge was calculated from the analyses in Table I, and by comparing the figures obtained in this way with the analysis of the cast iron produced, the loss or gain in the various constituents of the metal which took place during the melting was easily obtained. The results are shown in Table III. The analyses of coke, ash, limestone and slag are given in Table II.

Calculation of Heat Supplied to Cupola

In melting iron in a foundry cupola, there are three sources from which heat is derived. The most important of these is the coke, from which most of the heat is obtained; but in order to carry on these experiments with any degree of accuracy, it was necessary to take into consideration the amount of heat derived from the oxidation of carbon and silicon from the iron. The heating value of the coke was found to be 12,870 British thermal units per pound, as determined with the Mahler

bomb calorimeter. The amount of coke charged to the furnace was 528 pounds and 117 pounds of unburned coke were collected in the drop. This gives 528 — 117 = 411 pounds as the amount actually burned during the test. The heat supplied from the combustion of this coke was 411 × 12,870 = 5,285,000 British thermal units.

The amount of heat supplied to the furnace from the oxidation of a part of the carbon and silicon in the iron can be calculated easily from the following equations for the combustion of 1 pound of the element:

1.—$C + O_2 = CO_2 + 14{,}545$ B. T. U.

2.—$Si + O_2 = SiO_2 + 13{,}340$ B. T. U.

The amount of carbon lost from the iron during the melting process, as shown in Table III, amounted to 0.66 per cent of the total amount of iron charged. The heat derived from this source amounted to 2,400×0.0066 × 14,545 = 230,500 B. T. U., this figure being obtained by multiplying the number of pounds of carbon oxidized during the heat by the number of heat units which are liberated from the combustion of 1 pound of carbon. Similarly, the amount of heat derived from the oxidation of silicon from the metal, which takes place during the melting process is found to be 2,400 × 0.0025 × 13,340 = 80,100 B. T. U.

Adding the amounts of heat supplied to the furnace from all sources gives: Total heat supplied to furnace = Heat from the combustion of the coke + Heat from the oxidation of the carbon + Heat from the oxidation of the silicon = 5,285,000 + 230,000 + 80,100 = 5,595,100 B. T. U.

Where the Heat is Used

Knowing the sources from which the total amount of heat supplied to the furnace was derived, and also the quantity of heat derived from each source, the next step is to account for the way in which this heat is used. A careful study of the subject has shown that there are eight different ways in which the heat supplied to the furnace is used. They are:

1.—To melt the iron and superheat it to the required temperature.
2.—To heat the furnace lining.
3.—To decompose the limestone.
4.—To form slag.
5.—To heat the unburned coke.
6.—Sensible heat lost in the blast.
7.—Latent heat lost in the blast.
8.—Heat lost by radiation and convection.

Dealing with each heading individually, the method of calculating the amount of heat used for each purpose will be explained.

The efficiency of a cupola depends upon the percentage of the total heat supplied to the furnace which is used for melting and superheating the iron. The method of calculating the amount of heat used for this purpose is shown herewith:

Heat required $W\ (T_2 - T_1)\ S_1 + W\ (T_3 - T_2)\ S_2 + WH$.

Where

W = weight of iron melted = 2,400 pounds.

S_1 = specific heat of iron when solid = 0.1124.

S_2 = specific heat of iron when melted = 0.22.

T_1 = room temperature = 70 degrees Fahr.

T_2 = fusion temperature of iron = 2,192 degrees Fahr.

T_3 = average temperature of molten iron = 3,452 degrees Fahr.

H = heat of fusion of iron = 125 B. T. U. per pound.

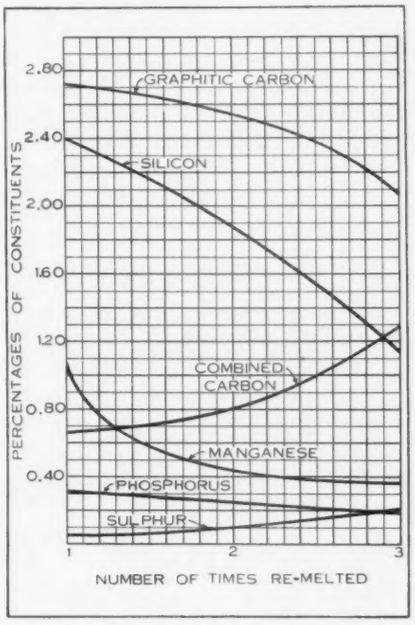


FIG. 5 — CHART SHOWING CHANGES IN COMPOSITION OF IRON AS RESULT OF REMELTING

Then the heat required to melt and superheat the iron = 2,400 (2,192 — 70) 0.1124 + 2,400 (3,452 — 2,192) 0.22 + 2,400 × 125 = 573,500 + 665,000 + 300,000 = 1,538,500 B. T. U.

In calculating the amount of heat used to raise the temperature of the furnace lining, it is assumed that the fire brick is at the same temperature as the gases escaping from the stack. The average value of this temperature, as obtained from the readings of the pyrometer, was 1,472 degrees Fahr. In order to obtain the amount of heat absorbed by the furnace lining, it is necessary to know the weight of this fire brick. The inside diameter of the furnace was 22 inches and the thickness of the brickwork, 4.33 inches; the height of the melting chamber was 78.8 inches.

The volume of the brickwork in the furnace is

$$\pi\left(\frac{\overline{30.66}^2}{4} - \frac{\overline{22.0}^2}{4}\right)78.80 = 3.1416\ (235 - 121)\ 78.80 = 3.1416 \times 114 \times 78.80 = 28{,}250 \text{ cubic inches} = 16.35 \text{ cubic feet.}$$

Knowing that a cubic foot of fire brick weighs 125 pounds, and that the specific heat of fire brick is 0.26, the heat required to raise the temperature of the furnace lining is

$$V \times W \times S\ (T_2 - T_1)$$

Where

V = volume of fire brick lining = 16.35 cubic feet.

W = weight of a cubic foot of fire brick = 125 pounds.

S = specific heat of fire brick = 0.26.

T_2 = temperature to which furnace lining is raised = 1,472 degrees Fahr.

T_1 = room temperature = 70 degrees Fahr.

Substituting known values in the above equation gives the amount of heat absorbed by the furnace as

16.35 × 125.0 × 0.26 (1,472 — 70) = 745,000 B. T. U.

Heat Used to Decompose Limestone

When heated to a temperature of 1,472 degrees Fahr., limestone gives off carbon dioxide and is reduced to the oxides of calcium and magnesium. The results of experiments have shown that 303 B. T. U. are required for each pound of limestone which is decomposed in this way. Heat is also absorbed by the stone in order to raise its temperature to 1,472 degrees Fahr. The total heat required for the decomposition of the limestone is thus found to be

$$W\ (T_3 - T_1)\ S + LW$$

Where

W = weight of the limestone in the charge = 154 pounds.

T = decomposition temperature of the limestone = 1,472 degrees Fahr.

T_1 = room temperature = 70 degrees Fahr.

S = specific heat of the limestone = 0.26.

L = heat required to decompose 1 pound of limestone = 303 B. T. U.

Substituting known values shows the heat used for decomposing the limestone to be

154 (1,472 — 70) 0.26 + 154 × 303 = 154 × 1402 × 0.26 + 154 × 303 = 56,150 + 46,600 = 102,750 B. T. U.

The results of experiments have shown that 990 B. T. U. are required for the formation of 1 pound of slag. Multiplying the number of pounds of slag collected from the drop by this figure gives the amount of heat that was used in forming the slag. Thus:

Heat used for slag formation = 990 × 263 = 260,500 B. T. U.

Any coke which passes through the furnace without burning must have its temperature raised to that of the

melted iron. The amount of heat required for this purpose is found by multiplying the weight of the unburned coke collected from the drop by the number of degrees which its temperature has been raised, and then multiplying this product by the specific heat of coke. The results of experiments have shown that coke has

Table I.
ANALYSIS OF THE IRONS CHARGED.

Constituents.	Scrap iron, per cent.	Pig iron, per cent.
Silicon	2.12	2.50
Graphitic carbon	2.65	4.19
Combined carbon	0.55	0.25
Total carbon	3.20	4.44
Manganese	0.45	0.55
Sulphur	0.07	0.03
Phosphorus	0.18	0.55

two specific heats; for temperatures below 482 degrees Fahr. its specific heat is 0.201, while at higher temperatures, its specific heat becomes 0.2337. Therefore, to find the amount of heat absorbed by the unburned coke, the following method of calculation is followed:

Heat absorbed by coke $W\ (482 - T_1)\ S_1 + W\ (T_2 - 482)\ S_2$

Where

W = weight of unburned coke = 117 pounds.

T_1 = room temperature = 70 degrees Fahr.

T_2 = temperature to which coke is heated = 3,452 degrees Fahr.

S_1 = lower specific heat of coke = 0.201.

S_2 = higher specific heat of coke = 0.2337.

Substituting known values gives the amount of heat absorbed by the unburned coke as

$117\ (482 - 70)\ 0.201 + 117\ (3,452 - 482)\ 0.2337 = 117 \times 412 \times 0.201 + 117 \times 2.970 \times 0.2337 = 9,740 + 81,600 = 91,340$ B. T. U.

Sensible Heat Lost in Blast

One of the most serious losses in the efficiency of a foundry cupola arises from the heat carried away in the gases discharged from the stack. This heat is in two forms: The actual heat carried away by the hot gases, and the latent heat, due to an incomplete combustion of the coke in the furnace.

In order to calculate the amount of heat lost in the blast, reference is made to the data obtained with Pitot meter and draft gage. The average value of the velocity head, which was secured with these instruments was 0.81 inch of water = 56.5 feet of air. Knowing that the velocity at which the blast is moving in the pipe is equal to $\sqrt{2gh}$

Where

g = attraction of gravity = 32.2 feet per second and

h = velocity head of the blast = 56.5 feet of air,

the required velocity of the blast is obtained by substituting known values.

$V = \sqrt{2gh} = \sqrt{2 \times 32.2 \times 56.5} = 60.3$ feet per second.

The radius of the discharge orifice of the blast pipe was 3 inches. This gives its area as $\pi r^2 = 3.1416 \times 9.0 = 28.3$ square inches = 0.1965 square feet. The volume of air discharged per second is $A \times V$.

Where

A = area of discharge orifice = 0.1965 square feet.

V = rate of travel of the blast in the pipe = 60.3 feet per second.

Substituting known values gives the volume of air discharged per second as $60.3 \times 0.1965 = 11.85$ cubic feet per second. The furnace was run under test for 67 minutes = 4,023 seconds. The total volume of air delivered to the furnace is thus $11.85 \times 4,023 = 47,630$ cubic feet. The average temperature of the gases leaving the furnace was 1,472 degrees Fahr. and at this temperature, their specific heat is 0.0201. The amount of sensible heat carried away by the gases is

$$V\ (T_2 - T_1)\ S$$

Where

V = total volume of blast = 47,630 cubic feet.

T_2 = temperature of escaping gases = 1,472 degrees Fahr.

T_1 = room temperature = 70 degrees Fahr.

S = specific heat of gases = 0.0201.

Subsituting known values gives the

Table II.
ANALYSES OF COKE ASH, LIMESTONE AND SLAG.

Coke Ash.	Per cent.
Silicon dioxide	49.04
Ferric oxide	29.46
Alumina	8.46
Calcium oxide	4.65
Magnesium oxide	3.21
Sulphur	0.94
Phosphorus	0.50
Limestone.	Per cent.
Silicon dioxide	0.24
Ferric oxide	0.88
Alumina	0.27
Calcium oxide	30.60
Magnesium oxide	21.25
Sulphur	0.00
Phosphorus	0.00
Carbon dioxide	47.18
Slag.	Per cent.
Silicon dioxide	51.67
Ferric oxide	12.59
Metallic iron	7.50
Alumina	1.35
Manganese oxide	8.92
Calcium oxide	12.76
Magnesium oxide	5.23
Sulphur trioxide	0.44
Phosphorus pentoxide	0.00

amount of sensible heat in the gases as

$47,630\ (1,472 - 70)\ 0.0201 = 47,630 \times 1,402 \times 0.0201 = 1,343,000$ B. T. U.

The gases escaping from the furnace have a certain percentage of carbon monoxide, due to the incomplete combustion of the coke in the furnace. The presence of carbon monoxide in the blast shows that all of the heat in the coke was not given up during combustion; this is what

Table III.
LOSS OR GAIN OF VARIOUS CONSTITUENTS IN MELTING.

Constituents.	Iron charged, per cent.	Cast iron produced, per cent.	Loss, per cent.	Gain, per cent.
Silicon	2.25	2.00	0.25	....
Graphitic carbon	3.16	2.35	0.81	....
Combined carb'n	0.45	0.60	....	0.15
Total carbon	3.61	2.95	0.66	....
Manganese	0.48	0.42	0.06	....
Sulphur	0.05	0.07	....	0.02
Phosphorus	0.30	0.39	....	0.09

Coke Charged.	Per cent.
Total carbon	89.50
Sulphur	0.20
Phosphorus	0.01
Ash	10.43
British thermal unit per pound.	12,870

Gases Discharged.	Per cent.
Carbon dioxide	1.2
Oxygen	2.4
Carbon monoxide	9.0
Nitrogen	87.4

has been referred to as the latent heat in the blast. Reference to the analysis of the furnace gases shows that there was an average of 9 per cent of carbon monoxide present. This gas has a calorific value of 4,349 B. T. U. per pound. Knowing that the total volume of blast was 47,630 cubic feet, 9 per cent of which was carbon monoxide, the volume of carbon monoxide discharged from the furnace was $47,630 \times 0.09 = 4,290$ cubic feet. One cubic foot of carbon monoxide weighs 0.0762 pound, consequently, the volume of carbon monoxide discharged from the furnace weighs $4,290 \times 0.0762 = 326.4$ pounds. The latent heat in this gas is then found to be $326.4 \times 4,349 = 1,422,000$ B. T. U.

A summary of these results is given in Table IV.

Thermal Efficiency of Cupola

The thermal efficiency of a cupola is commonly spoken of as the percentage of the total heat supplied to the furnace which is used for melting the iron and superheating it to the temperature at which it is tapped from the furnace. Taken on this basis, it will be noted in Table IV that the efficiency of the furnace was 27.50 per cent during the heat from which the preceding data were taken. But in operating a furnace, heat is required to raise the temperature of the fire brick lining and to form slag; both of these functions are an essential part of the furnace operation, and it seems that the heat used for these purposes should be credited to the furnace efficiency. Figuring on this

basis, the furnace efficiency would be 47.34 per cent for the test under discussion.

In working for a high furnace efficiency, the arrangement of the charge and the duration of the heat are the points of importance. Referring to the data which show the arrangement of the charge, it will be noted that the bed consisted of approximately 1 pound of coke for each 3 pounds of iron, while for subsequent additions, the ratio of coke to iron was roughly 1 to 10. The object of having this large quantity of coke in the bed charge was to provide sufficient fuel to enable the furnace to burn under natural draft for about an hour before the blast was turned on. In this way, the furnace is preheated, and hot iron can be obtained in about six minutes after turning on the blast. The cost of the coke used to heat the furnace in this way is considerably less than the cost of power for driving the blast fan, if the furnace were heated under blast.

How to Secure Maximum Efficiency

To secure the maximum efficiency in operating the furnace, it will be noted from the preceding data that a foundry should arrange to run its heats for the longest possible periods of time. There are several reasons in favor of this practice. In the first place, relatively little heat is lost by radiation, so that it is advisable to make the greatest possible use of the heat which has been used to raise the temperature of the furnace lining. Evidently, the percentage which this amount of heat is to the total supplied to the furnace during the run decreases as the length of the run is extended.

It is also important to charge the furnace in such a way that it is kept filled practically to the level of the charging door at all times. This not only keeps an ample supply of metal ready to be poured at all times, but it enables the greatest amount of heat to be taken up from the gases escaping from the cupola. Where charging is conducted in this way, the iron is heated well toward the melting point before it reaches the melting zone in the furnace and, in consequence, it is possible to get hotter metal for the same amount of coke. This point was brought out from the readings of the pyrometer in the furnace above the charging door. When charging was going on regularly, so that the furnace was kept filled to about the level of the door, the temperature of the escaping gases rarely exceeded 1,380 degrees Fahr., but when the level of the charge was allowed to drop, the temperature would rise as high as 1,800 degrees Fahr.

The results of the gas analyses also showed that the percentage of carbon monoxide runs up rapidly when the level of the charge in the furnace is allowed to drop. In extreme cases, the amount of carbon monoxide was three times as great for a low level of the charge as it would be under normal conditions. This means a corresponding loss of efficiency, due to the latent heat that is being carried away in the gases.

The magnitude of the loss which is occasioned by allowing the level of the charge to fall will be apparent, when it is remembered that the average amount of sensible and latent heat carried away in the gases was 49.45 per cent of the total heat supplied to the furnace, for the test from which the data for this article were taken.

The affect which remelting has upon the iron is due to changes which are made in the percentages of such constituents as carbon, silicon, and sulphur which it carries. Before entering upon a discussion of the way in which remelting affects the iron, a brief review of the influence of different constituents upon the properties of the metal will be of value.

Table IV.
SUMMARY OF HEAT UNITS REQUIRED.

	B. T. U.	Per cent of total.
1.—Heat used to melt and superheat iron	1,538 500	27.50
2.—To raise temperature of furnace lining	745,000	13.34
3.—To decompose limestone	102,750	1.84
4.—To form slag	260 500	4.66
5.—To heat up unburned coke	91,340	1.63
6.—Sensible heat lost in blast	1,343,000	24.15
7.—Latent heat lost in blast	1,422,000	25.40
8.—Heat lost by radiation (estimated)	3,200	0.18
Total heat accounted for		98.70
Heat unaccounted for		1.30
Total heat supplied to furnace	5,595,000	100.00

Carbon

Carbon occurs in iron in two forms, as graphitic and combined. Graphitic carbon exists as a foreign substance, which has crystallized out from the iron upon cooling, but which still coheres to the metal. The combined carbon is held in chemical union with the iron as a carbide. The presence of combined carbon causes the metal to be very close-grained and hard; consequently, castings with a high content of combined carbon are hard to machine. For this reason, a high percentage of combined carbon is usually regarded as a disadvantage. The crystals of graphitic carbon distributed through the iron tend to break the continuity of the metal and give it a slightly porous structure; this makes castings with a relatively high percentage of graphitic carbon easy to machine, and as most castings have to go through some sort of finishing process, the advantage of having a soft metal to work with has led irons with from 2.5 to 4 per cent of graphitic carbon to be looked on with favor. The presence of graphitic carbon has the further advantage of reducing the amount of shrinkage which takes place when the molten metal cools in the mold, because the expansion caused by the separation of the crystals of graphite counteracts the contraction that takes place when the metal cools.

Silicon

Silicon probably exists in iron as a silicide and is a desirable constituent in amounts of from 1 to 3 per cent. The presence of silicon in these amounts tends to prevent the formation of combined carbon by changing it to the graphitic form. It is estimated that the presence of 0.15 per cent of silicon will prevent the formation of 0.03 per cent of combined carbon in the iron. Consequently, silicon is the means of producing soft castings and of preventing a part of the shrinkage which naturally occurs while the metal is cooling in the molds. The presence of silicon has the further advantage of producing a very fluid metal that runs freely in the molds. It also reduces the tendency for oxide and blow-holes to form in the castings.

Sulphur exists in the iron as a sulphide and is injurious for the following reasons: It causes the metal to flow sluggishly, thus tending to give it time to cool before it has filled out the molds; it also produces shrinkage and blow-holes. From the foregoing, it is evident that the presence of sulphur in iron tends to counteract the good effects of silicon, 0.01 per cent of sulphur being able to offset the good done by 0.15 per cent of silicon.

The phosphorus which occurs in iron is in the form of a phosphide.

If present in amounts greater than 0.8 per cent, it makes the castings brittle and by causing the carbon to be held in the combined form, it is responsible for the objectionable features already mentioned in connection with the discussion of carbon. For most foundry work, the phosphorus content of the iron should lie between 0.5 and 0.8 per cent.

Manganese exists in iron as an alloy. In quantities of less than 1 per cent it is beneficial, owing to its ability to increase the strength of the iron and to counteract the harmful affects of sulphur. Where the quantity of manganese exceeds 1 per cent, there is a marked tendency for the castings to become hard and deficient in strength.

Classification of Foundry Irons

Taking into consideration the compensating affects of silicon and sulphur, upon the properties of the iron in which they exist, a classification has been made, based upon the percentages of these two constituents which are present. Foundry irons have been divided into four classes, as shown in the following table, No. 1 being the best grade of iron.

	No. 1 Per cent.	No. 2 Per cent.
Silicon	2.75	2.25
Sulphur	0.035	0.045
	No. 3	No. 4
Silicon	1.75	1.25
Sulphur	0.055	0.065

Taking the effects of the different constituents of a foundry iron into consideration, attention is turned to the results of the analyses of the iron before and after melting, in order to see how its properties are likely to have been altered by passing through the cupola. Reference to Table III shows that the metal lost silicon, graphitic carbon and manganese during the melting process, while it gained in combined carbon, sulphur and phosphorus.

The results of experiments have shown that the total carbon content of the iron is not affected by melting unless the percentage of carbon is abnormal. The usual results show that the loss in graphitic carbon is approximately equaled by the gain in the combined carbon. This change in the relation of the amounts of graphitic and combined carbon means that the resulting metal will be closer-grained and harder than one would expect from the analysis of the charged metal; the shrinkage will also be greater, owing to the reduction in the amount of graphitic carbon carried by the metal.

It has also been noted that the cast iron obtained from the furnace was higher in sulphur and lower in silicon than the charged metal. This condition explains the change which has taken place in the relative amounts of graphitic and combined carbon, as it will be remembered that silicon has the power to precipitate carbon out as graphite, while sulphur counteracts the affect of silicon in this respect. The presence of higher sulphur and lower silicon will also have a tendency to make the molten metal more sluggish.

Where the amount of manganese carried by the iron exceeds 1 per cent, it has been found that melting tends to reduce the quantity of this constituent, but where there is only 0.3 or 0.4 per cent of manganese present, little reduction takes place. This was the condition with the iron used for the test under discussion, and the loss of manganese amounted to only 0.06 per cent.

The results of most experiments have shown that the percentage of phosphorus carried by the iron after melting is essentially what it ought to be, according to the analysis of the metal composing the furnace charge and little change in the amount of this constituent takes place.

The loss of manganese and silicon that takes place during the melting process is doubtless due to oxidation. In the case of graphitic carbon, the loss is due to the joint influence of oxidation and the affect which the reduction in silicon and increase in sulphur have upon the condition in which the carbon exists. This is the partial cause of the increase in the amount of combined carbon found in the metal after melting; the other reason for this increase is found in the solvent action of the molten iron upon the carbon supplied by the coke. Similarly, the increase in the amount of sulphur is due to the absorption of this element from the coke during the melting process. The changes that occur in the iron in remelting are shown in Fig. 5.

Special Mixtures

For many years foundrymen have used special metal mixtures for specific classes of work. The chemist has shown the reason for their suitability for these uses to be due to the effect which the different constituents of the iron have upon the properties of the metal. Knowing the effect which melting has upon the percentage of each constituent, and the influence which each of these constituents has upon the properties of the iron, the scientific foundryman aims to mix the metals making up his furnace charge upon the basis of their analyses, the object being to produce iron that is suitable for the class of castings that are to be poured. And this is exactly the definition of scientific management that was given at the beginning of this article—adding to the common sense methods that have been used in the past, the more exact methods of control over product and efficiency that have been worked out by scientific men.

Show Room for Foundry Equipment

J. W. Jackman & Co., Ltd., London, have established a large foundry equipment display room at Manchester, Eng. Molding machines, cupolas, cleaning room equipment, etc., are shown in operation and every opportunity is afforded to foundrymen to witness the methods of employing this equipment.

The molding machines installed include types manufactured by Henry E. Pridmore and the Vulcan Engineering Sales Co., Chicago, and the Adams Co., Dubuque, Ia. Cupolas, ladles, etc., built by the Whiting Foundry Equipment Co., Harvey, Ill., are exhibited and the core machines are of the type manufactured by the Wadsworth Core Machine & Equipment Co., Akron, O. Other equipment includes the following: Sprue cutters, Benjamin Middleditch, Detroit; magnetic separators, Dings Magnetic Separator Co., Milwaukee; tumbling barrels, Globe Machine & Stamping Co., Cleveland; foundry supplies and specialties, S. Obermayer Co., Chicago, and steel cement, Clark Cast Steel Cement Co., Shelton, Conn.

Purifying Scrap Copper

A method of purifying scrap copper or scrap copper alloys has been patented recently by W. S. Rockey and Hilliary Eldridge, of New York, in which the metal is melted under a flux consisting principally of boron trioxide. The flux is first fused in a suitable furnace and the scrap metal is then charged when the metal melts it, sinks below the molten flux, which, it is stated, dissolves the impurities from the molten metal with which it comes into contact. An addition of carbon is then made to the flux, which enables it to still further reduce the impurities. What the impurities consist of, and why the flux should attack them and not the metals composing the alloy, is not stated in the patent specifications.

THE BRASS FOUNDRY

Casting Copper in a Permanent Mold

By C Vickers

NECESSITY, it has been said, is the mother of invention, and this old proverb seems especially applicable to the subject in hand, as the method of casting, here outlined, was originated by the necessity for the employment of methods radically different from those usually followed. The casting, illustrated in Fig. 1, is a terminal head made of cast copper, and two of these heads are connected by four lengths of heavy, flexible copper cable forming a terminal which is used to carry the current to the electrodes of electric furnaces of the arc type.

Each terminal head weighs about 70 pounds, and it is necessary that the casting shall be sound and free from all blemishes in order to obtain good contact. It is essential, also, that the copper be of high conductivity, and the thin wires composing the cable strands must not be burned where they enter the head. The four cables composing each terminal are several feet in length and with the heads cast in, weigh several hundred pounds.

Difficulties of Green Sand Molding

The job is a particularly difficult one to handle in green sand molds because the length, weight and flexibility of the cables makes it almost impossible to secure them in position in the mold unless special rigging is provided to firmly clamp them together in their proper relation to each other. If made in green sand it would be necessary to provide openings in the sides of the flask through which the cables would extend, and the free ends of the cables would have to be firmly bound to prevent the strands from fraying and digging into the surface of the mold. After providing for all of these conditions, other difficulties would be encountered in anchoring the free ends of each cable to prevent them from floating to the upper surface of the mold, in avoiding "run-outs" around the cable prints and in heating the cables to prevent the castings from blowing. In Fig. 2, a terminal head is illustrated that was cast in a sand mold, and in this case the brass founder ingeniously overcame some of the difficulties incident to holding the cables in place, by first casting a sleeve around the end of each cable, as shown at *A*, Fig. 2.

These sleeves held the strands of the cables firmly together, thus making it less difficult to secure them in place in the mold, but it had the disadvantage of introducing an element of uncertainty as to electrical connection, and occasionally the wires would be burnt and brittle and sometimes a casting would be lost which would entail a considerable additional loss in sections of the four cables.

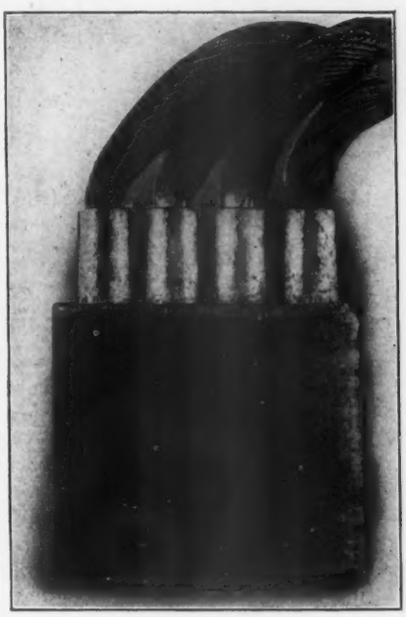


FIG. 1—A COPPER TERMINAL HEAD, WEIGHING 70 POUNDS, CAST IN A PERMANENT MOLD

It will be appreciated, therefore, that it was a problem of some difficulty to make these castings by the methods usually employed and that there was imperative need for improvement. In addition to the expense and uncertainty of results, the castings were never perfect. The one shown in Fig. 2 was one of the best obtained and it will be noted that it contained numerous defects, especially in the vicinity of the gate.

The Permanent Mold

The five holes, symmetrically arranged, which are shown extending through the casting in Fig. 2, are the bolt holes for connecting the terminal. The idea of using an iron mold for making these castings originated with P. Morris, master mechanic of the Titanium Alloy Mfg. Co., and was applied by him at the company's works at Niagara Falls, N. Y. Fig. 4 shows the mold open, with the casting remaining in one-half. It was designed to be poured upright through gates extending to the bottom in the manner illustrated. The cables were suspended by means of tackle which permitted the cables to be raised or lowered as required.

The mold is prepared for casting by first coating it with plumbago and then polishing the surfaces. The two halves then are adjusted in proper relation to each other and are separated sufficiently to permit the cables to be easily inserted. The mold then is closed and is secured by ¾-inch bolts, arranged sufficiently close to bind the halves firmly together and to prevent warping. As the thickness of the terminal is of no particular consequence as long as the cables are well covered with metal, the mold at the beginning was made sufficiently large to allow two or three cuts to be planed off in succession from the surfaces of the joints, so that when the latter were burnt or eroded, a new surface could be obtained by machining. When a terminal is cast on one end of the cables, it is removed from

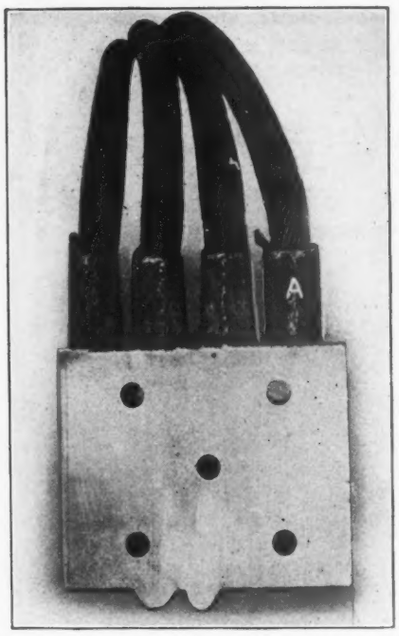


FIG. 2—COPPER TERMINAL HEAD CAST IN A SAND MOLD

the mold and the cables are turned end for end in readiness for casting the other terminal.

In Fig. 3 the mold is shown bolted together and containing a casting just poured. No special precautions are necessary in pouring the metal as there is neither a kick nor blow. The copper is poured into the mold through one of the sprues only and the use of two sprues is merely a convenience, as either can be used for right or left hand pouring. One great advantage of the iron mold is that it can be heated easily and the heat, at the same time, is transmitted to the cables. The mold is heated after the mold and cables are assembled, a Hauck kerosene torch being utilized for this purpose. The torch is applied to the outside of the mold, care being exercised to heat it as uniformly as possible. The metal enters the mold quickly without the slightest sign of agitation.

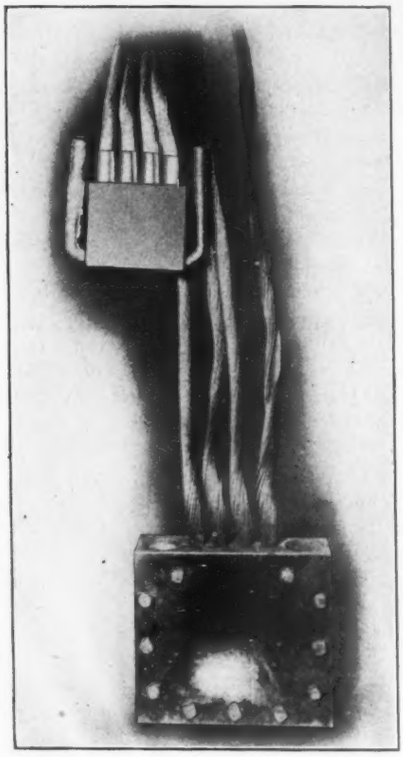


FIG. 3—PERMANENT MOLD ASSEMBLED FOR CASTING HEAVY COPPER TERMINALS

Advantages of Permanent Mold Process

Fig. 1 shows the casting that was obtained in the permanent mold and Fig. 2 illustrates the product of the sand mold, the disadvantages of which were previously noted. Seldom are defects found in the permanent mold castings after they have been machined, although the castings occasionally appear a little spilly, due to the wires interfering with the stream of metal. This effect, however, does not extend below the skin of the casting to any extent and it is removed by the first cut on the planer. The advantages of the permanent mold for castings of this type are so apparent that no attempt will be made to enumerate them, beyond pointing out the effect of a chill on the structure of the metal itself. It is well known that the density and strength of non-ferrous metals is greatly improved by rapid cooling and that the conductivity of copper is increased, the latter quality being especially desirable in electrical work.

The copper is melted in bottom-pour crucibles in straight shaft, coke-fired furnaces. Charcoal is used as a cover and every precaution is taken to prevent the oxidation of the metal. To obviate porosity, titanium-copper is used as a deoxidizer in the proportion of one-half of 1 per cent and is added to the molten copper 10 minutes before it is removed from the furnace. With this proportion of titanium-copper an electrical conductivity of 93.83 per cent is obtained when the conductivity of the copper before melting is 99.55 per cent. As low as one-fourth of 1 per cent of titanium-copper will produce, in sand molds, sound, clean copper castings, having a conductivity of 96.95 per cent, provided copper that is clean and free from oxide is used. One-fourth of 1 per cent, however, is very low and as a little neglect in melting the copper might result in the production of unsound castings, it was considered advisable to sacrifice a small percentage of the conductivity in this case in order to eliminate all possibility of failure, because of the expense attending the loss of the copper cables.

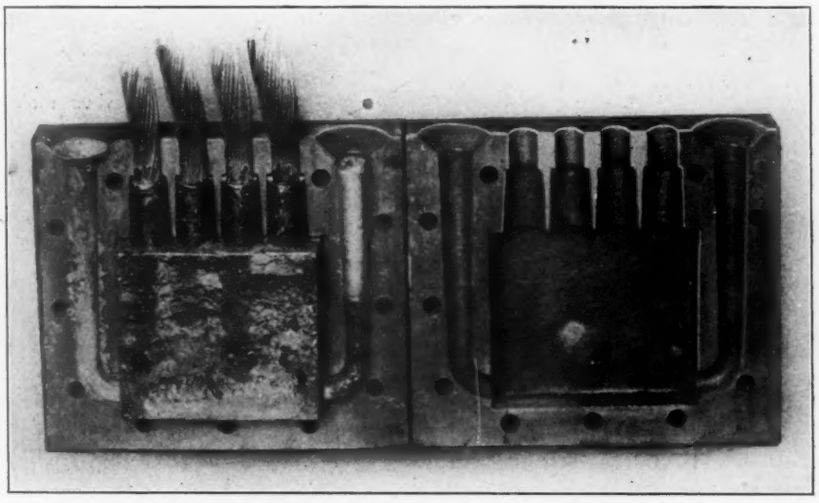


FIG. 4—PERMANENT MOLD FOR CASTING COPPER TERMINAL HEADS

Investigation of Metal Losses

The committee appointed by the American Institute of Metals to cooperate with the United States Bureau of Mines is desirous of aiding the latter in its investigation of the efficiency of brass melting furnaces and its endeavor to lessen metal losses incidental to melting, by obtaining from the members of their organization data on the results obtained in actual practice. A list of questions has been submitted to the members of the American Institute of Metals covering the construction and operation of brass-melting furnaces. The basis for the data is a working day for one furnace, and the questions are intended to elicit information

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

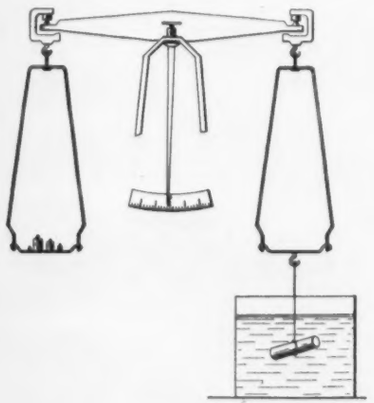
Note.—This sheet may be cut into two sections 5 x 7 inches, and may be readily bound in note-book form.

NOTES ON SPECIFIC GRAVITY---I

By W. L. Tryon

The *specific gravity* of a substance is its weight compared with the weight of an equal volume of water. According to Archimedes' principle, the difference between the weight of a body in air and the weight of the same body submerged in water, is equal to the weight of the water displaced, or in other words, the weight of an equal volume of water. Therefore, to find the specific gravity, divide the weight of the body in air by the difference between its weight in air and its weight in water, at standard temperature.

There is no general agreement in regard to standard temperature, experimenters using 32 degrees Fahr., 39.1 degrees Fahr., 60 degrees Fahr., and 62 degrees Fahr., but 62 degrees Fahr. is the temperature now most generally used.



The formula for specific gravity is

$$\text{S. G.} = \frac{W}{W - w}$$

where

W = weight of body in air.

w = weight of body submerged in water.

S. G. = specific gravity.

The illustration shows the method of weighing a submerged body.

NOTES ON SPECIFIC GRAVITY---II

By W. L. Tryon

To find the specific gravity when weight per cubic inch or weight per cubic foot is given, multiply the weight by the constants given below, corresponding to the temperature at which the specific gravity is required.

Constants (weight per cubic inch given).

Temperature, degrees Fahr.	32	39.1	60	62
Constant	27.6840	27.6809	27.7015	27.7123

Constants (weight per cubic foot given).

Temperature, degrees Fahr.	32	39.1	60	62
Constant	0.016021	0.016019	0.016035	0.016037

To find the weight per cubic inch or weight per cubic foot, when the specific gravity is given, multiply the specific gravity by the constant given below, corresponding to the temperature, which was used as standard.

Constants for weight per cubic inch.

Temperature, degrees Fahr.	32	39.1	60	62
Constant	0.036122	0.036126	0.036090	0.036085

Constants for weight per cubic foot.

Temperature, degrees Fahr.	32	39.1	60	62
Constant	62.418	62.425	62.364	62.355

To find the specific gravity at 62 degrees Fahr. when the specific gravity at one of the above temperatures is given, multiply the given specific gravity by one of the following constants:

Temperature, degrees Fahr.	32	39.1	60
Constant	1.00101	1.00122	1.00014

regarding the type of furnace, its shape and dimensions, character of lining, thickness and other details of construction. Information is also desired relative to the size of crucible used, the kind of fuel, character of air supply, the amount of fuel consumed, number of heats per day, the frequency with which the furnaces are relined and otherwise repaired, and how many heats are obtained from each crucible throughout its life. To arrive at the metal losses, the total pounds of metal poured per day per furnace should be stated, after deducting all losses by oxidation in the slag or by skimming. The total pounds of metal recovered from the drossage of each furnace should also be given as well as the net percentage of loss, taking account of all metal recovered. Discussion is invited of the relative advantages and disadvantages of the various types of furnaces tried by each member, with any observations touching upon the quality of the metal produced by the various furnaces. Other questions relate to the manner in which the health of the employes is safeguarded. Replies will be considered confidential by both the committee and the Bureau of Mines, and the members replying to the list of questions will be placed on the mailing list of the Bureau of Mines, and will receive the various publications which are sent out by this government bureau from time to time.

BRASS FOUNDRY DIFFICULTIES

Solved by Experts

Aluminum Alloy for Hollow Ware

We would like to have an aluminum alloy suitable for hollow ware, such as kettles, pans, etc. We also would like to know how to mix the so-called No. 12 alloy. Can rolled aluminum scrap containing 99 per cent aluminum be used in aluminum mixtures?

The No. 12 aluminum alloy to which you refer is suitable for hollow ware. It contains 8 per cent copper. Aluminum scrap can be used to advantage in making this mixture. A hardener first should be made consisting of 50 per cent copper and 50 per cent aluminum and this can be used in making this alloy in the proportion of from 15 to 16 pounds with the balance aluminum.

Casting Brass on Steel

We are experiencing considerable difficulty in casting a brass lug onto a steel tube. The mixture we are using consists of copper, 79 per cent; tin, 6.22 per cent; lead, 5.33 per cent; zinc, 3.41 per cent, and antimony, 6.04 per cent. The steel tube is 2½ inches in diameter and the metal cast around the tube is ⅛ inch thick. The castings are porous, although where the metal comes in contact with the tube it is sound.

The difficulty is probably due to the mixture you are using, as the amount of antimony it contains is abnormal. We suggest that the antimony be omitted, as it serves no useful purpose, but tends to make the alloy brittle and unsound. Increase the copper by the amount of antimony omitted and the alloy will be a good average bronze. The metal should be carefully melted to avoid oxidation, plenty of charcoal being used. The alloy is sound where it comes into contact with the steel tube, because, being chilled, it solidifies quickly, which always has a tendency to increase the density of copper alloys.

Casting Silver

I have a silver chalice to make and I would like to know whether I can mold it in the ordinary manner. What are the casting qualities of silver and does it shrink to any extent? If there are any other difficulties involved in the casting of this metal I would be pleased to have you furnish me with all the necessary data.

The chalice can be molded in the ordinary manner, provided very fine sand is used, and perhaps better results thus can be obtained than would be possible when using plaster of paris molds, unless the latter are skillfully handled. The silver should be melted in a clean crucible and just before pouring about 0.25 per cent of cadmium may be added to insure solid castings.

Cost of Fuel for Melting Aluminum

We would like to know the cost of melting aluminum with coke. The cost of this fuel per pound or ton of melted aluminum would be appreciated.

The fuel cost will depend entirely upon the form of the aluminum to be melted. Thus, in melting scrap aluminum wire, the fuel cost was found in one case to approximate $5 per ton of metal and the labor cost was $26 per ton. The approximate cost of ingoting such material was found to be $2.61 per hundred pounds of metal. This excessive cost was due to the tedious nature of the operation, and is mentioned to show how the character of the material influences the cost of melting. In melting ingots for casting purposes the fuel cost would be only a small proportion of the above; in the case cited the fuel ratio was 4 to 1, but with ingots it should be 10 to 1.

Effect of Impure Metals on Manganese Bronze

The manganese bronze which we are making does not develop a tensile strength of 60,000 pounds per square inch, although we use a mixture consisting of 56 pounds of copper, 41.38 pounds of zinc; tin, 0.75 pound and aluminum, 0.5 pound. After the copper has been melted under a cover of charcoal we introduce 2.75 pounds of manganese-copper containing 4 per cent iron. The zinc is added next and after permitting the crucible to remain in the furnace for ten minutes it is removed and aluminum and tin additions are made in order.

The inferior quality of this manganese bronze undoubtedly is due to the use of impure metals in making the alloy. Scrap copper should not be employed if high tensile strength is desired and the zinc should be as free from lead as possible. Therefore, brands of known purity only should be used. Your mixture should show a tensile strength ranging from 68,000 to 75,000 pounds per square inch, but it will have to be carefully made, as the percentage of zinc is high and the mixture is liable

to be crystalline or will appear imperfectly mixed. If this condition develops, the amount of the zinc in the mixture should be decreased to 40 and possibly 38 per cent. The aluminum should be added before the zinc and the tin addition should be made last to insure a thorough mixture of the various metals. I suggest that you ingot the first melt.

White Metal Pattern Mixture

Can you give me the mixture that is used in making white metal transmitters for telephones? I would like to use a similar mixture for making master patterns.

An excellent white metal mixture for master patterns follows: Tin, 65 pounds; antimony, 6¼ pounds; copper, 3¾ pounds; lead, 25 pounds, and aluminum, 10 ounces.

Alloy for Casting in Iron Molds

I would like to obtain a formula for an aluminum or a cheap alloy to replace a mixture we are now using which consists of 48 parts of tin, 8 parts of antimony and one part of copper. The aluminum alloy would have to be cast into a wrought iron mold, the castings serving as handles for table knives. It is essential that the aluminum alloy should retain a smooth surface and should be tough.

An alloy that might be found satisfactory follows: Aluminum, 87 per cent; copper, 8 per cent, and tin, 5 per cent. A cheaper mixture would be zinc, 83.5 per cent; tin, 8 per cent; copper, 8 per cent, and aluminum, 0.5 per cent.

Fuel Melting Ratio for Brass

We would like to know the melting ratio of coke to brass. Also, we would like to have you advise us how many No. 70 pots can be poured from a furnace during a period of 9 hours and approximately how much coke should be consumed.

Available figures regarding the melting ratio of coke to brass usually indicate a minimum fuel consumption, as few manufacturers care to admit how much coke they really use. It has been stated that the average melting ratio is from 40 to 50 pounds of coke per 100 pounds of brass melted and one statement was to the effect that 25 pounds of coke was used per 100 pounds of metal. These figures, however, should be taken with the proverbial grain of salt, as in reality the coke consumption is much higher. The amount of coke consumed will of course, depend entirely upon the space between the walls of the furnace and the sides of the crucible and the consumption of fuel will vary accordingly. It must be rembered, however, that there is a limit to the size of the coke in natural draft furnaces, because if used very fine—say the size of chestnut coal—the draft is impeded and the fires will not attain the maximum temperature. There is, therefort, no economy in using too large a pot or in breaking the coke too small to charge it around the pot. Consequently, the melting ratio of coke to brass is liable to seem high and it will be much higher per ton in the case of a foundry making small castings than in one devoted to heavy work, on account of the high percentage of gates to castings when the latter are small. In one brass shop making light castings exclusively, the coke ratio per pound of finished castings, including coke for drying cores and other foundry purposes, averaged 125 to 130 pounds per 100 pounds of castings made. The number of No. 70 pots that can be poured in 9 hours depends entirely upon the efficiency of the furnace, the skill with which it is managed and the metal. For copper it is usually from three to four heats; brass, from four to six heats, is good practice.

Use of Improper Sand

We cast brass hemispheres varying in diameter from 14 to 31 inches and which have a very thin shell. The facing we use on our molds is a good grade of graphite, but we have found it necessary to bake the molds at a high temperature for a considerable period to prevent scabbing. We use a special, heavy sand containing a considerable proportion of a clay, which, of course, gives a very firm mold after baking. Is there any facing or method that you could recommend whereby we could dispense with this baking at a high temperature which is now necessary? The molds, of course, will have to remain fairly open to prevent blowholes and spongy castings, as it is necessary that these castings should be absolutely tight.

The difficulty in this case is due to the sand being too heavy for molding purposes. It contains too much loam or clay which is proved by the fact that when baked it makes a firm mold, which has a tendency to scab. The sand should be either a No. 1 or No. 2 and should be free and open. For dry sand molds some binder, such as flour, should be used. We doubt whether a facing would be of much assistance if the loamy sand is used as a backing, as its close texture would hold back the gases generated in pouring and there would be more scabbing. A thorough use of the vent wire through the backing might help, in which case a facing composed of one-half sharp or core sand, one-half heap sand and flour in the proportions of 1 to 16 could be used to advantage. The mold should be well-sprayed with molasses water and skin-drying ought to be sufficient instead of baking. Unless the castings are very thin and difficult to run, there should be no difficulty in making them in green sand molds if the proper grade of sand is used.

Wear of Bronzes

In a paper on the "Wear of Bronzes," presented at the Sixth International Testing Congress, by A. Portevin, of Paris, and E. Nusbaumer, of Liege, Belgium, it is stated that the researches were undertaken to determine the influence of the chemical composition on the wear of bronzes. None of the specimens was subjected to thermal treatment, but the apparatus employed for making the tests was the Derihon mill. The authors arrived at the following conclusions:

1. — The wear of the ordinary bronzes is proportional to the contents of tin.

2.—The introduction of phosphorus has the effect of creating a bronze which wears less than non-phosphorus bronzes of high tin percentage and more than non-phosphorus bronzes of low tin percentage.

3.—When the bronzes are submitted to constant friction, account should be taken of the phenomena of cold work, which tends to diminish the wear until the limit of the depth to which the cold work has penetrated is reached.

Anti-Corrosive Alloy

A new aluminum alloy, which, it is contended, is non-corrosive and suitable for the production of the metal parts of mining machinery, or as a coating for such castings, has been patented by Gaston Jacquier, Johannesburg, South Africa. The alloy consists of aluminum, bismuth, copper, silicon and magnesium, and either of the following mixtures can be used: Aluminum, 92 per cent; bismuth, 2 per cent; silicon, 1 per cent, and copper, 5 per cent; or, aluminum, 91 per cent; bismuth, 2 per cent; magnesium, 2 per cent, and copper, 5 per cent.

Well-Equipped Milwaukee Gray Iron Foundry

Methods of Molding Some Intricate Castings, With a Brief Description of the Chain Belt Co.'s Shop

EXTENSIVE additions and improvements have recently been made to the gray iron foundry of the Chain Belt Co., Milwaukee. The shop is now 200 feet in length and 70 feet wide, divided into a main aisle 36 feet wide and two side bays, each 17 feet. The output includes castings for concrete mixing, elevating and conveying machinery, gas engine cylinders, machine tools, etc. The Chain Belt Co. manufactures an extensive line of elevating, conveying, power transmitting and concrete machinery. The company makes all of its own gray iron castings and takes in considerable outside work as well. The main bay is spanned by two Pawling & Harnischfeger traveling cranes, 10 and 5 tons capacity each. Iron is melted in a 48-inch Whiting cupola, the blast being furnished by a No. 5 Roots centrifugal blower. At night artificial illumination is furnished by standard arc lights hung under the crane rails. The lights are spaced about 30 feet apart and are swung 10 feet high.

The facilities of the shop may best be covered by describing some of the difficult castings which are produced. In Fig. 2 the pouring of a large concrete mixer drum is illustrated, the casting itself being shown in Fig. 3. The blades or paddles, shown in the latter illustration are, of course, not a part of the casting. These drums are made in various sizes from 800 to 4,000 pounds, the casting shown in Fig. 3 weighing approximately 1,000 pounds. As illustrated in Fig. 2, a three-part, circular iron flask is used.

Molding the Drag

The drag, which is only about six inches deep, contains only the impression of the flange, *F*, Fig. 3. The pattern is made in two parts and is cut at the upper edge of the upper flange, *L*. Therefore, only the flat dome-shaped portion of the drum extends into the cope. The large green sand core in the center is rammed on a lifting plate so that it can be removed and slightly dried with a torch. Cone-shaped guide pins are fixed to the plate in order that it may be replaced in the same position from which it is removed. The casting is poured through four gates, two on each side. The gates are fed through a single runner box as shown in Fig. 2.

To insure tough, wear-resisting castings, these drums are poured with metal containing a large amount of steel. A typical mixture for this work is as follows:

		Analyses			
Material.	Weight, pounds.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Manganese, per cent.
Pig iron	700	2.35	0.013	0.487	0.76
Pig iron	700	2.68	0.011	0.688	0.92
Steel rail	600	0.020	0.005	0.005	0.50
Hard sprue ..	400	1.75	0.045	0.600	0.45
Soft sprue ...	800	2.35	0.075	0.750	0.36

From the foregoing it is readily computed that the casting contains approximately 1.69 per cent silicon, 0.045 per cent sulphur, 0.521 per cent phosphorus, and 0.49 per cent manganese. The hard steel sprues are obtained, of course, from the previous melt.

Fig. 4 shows an aluminum pattern of a gas engine cylinder with crank case attached. The engine is of the two-cylinder opposed type, designed for driving a gasoline tractor. The cylinder is molded on end with the green sand crank case core extending down from the cope. A three part flask is used but the drag con-

FIG. 1—GENERAL VIEW OF THE CHAIN BELT CO.'S GRAY IRON FOUNDRY

tains only the bore core print, *R*. The cheek is 29 inches high and contains the whole cylinder, including the crank case. The casting weighs about 400 pounds and 14 molds per day have been made by two molders and two

FIG. 2—POURING A SEMI-STEEL CONCRETE MIXER DRUM

helpers. The flasks are rammed on a 20-inch Mumford jarring machine provided with a 5-foot table.

In handling this job in the shop the procedure is as follows: The pattern is placed on a bottom board in an upright position exactly as it appears in Fig. 4. The cheek part of the flask is set over the pattern and the whole is filled with sand and rammed. Next the drag is rammed and is placed on top of the cheek, the two being clamped together. Following this operation both drag and cheek are rolled over and the pattern is drawn from the sand, the impressions of the lugs or projections on the cylinder head, *P*, Fig. 4, having been made by small loose patterns. The cope is rammed on a follow-board shaped to conform to the interior of the crank case. The cope bars extend down into the follow-board and with the aid of gaggers hold the hanging green sand core in place. After the cope has been rammed and finished it is set on the cheek and the whole is clamped together. The green sand core hanging from the cope forms the crank case cavity, *C*, Fig. 4. A dry sand core is used for the bore of the cylinder and another annular dry sand core forms the water jacket. These are set by lifting the cheek off the drag before the flask is finally closed. The mold is not skin dried but is poured green.

In the May issue of THE FOUNDRY, pages 185 and 186, an article describing a method of molding and casting gas engine cylinders similar to the one under consideration, was published. Some interesting comparisons may be made by referring to this article, the cylinders in the former case having been cast horizontally instead of vertically, using dry sand cores throughout.

For drying large molds an oven 15 feet square and 7 feet high inside, has been constructed. It has a number of interesting features. The roof consists of reinforced concrete slabs supported between I-beams spaced about 2 feet apart. The reinforcement consists of ½ inch transverse rods embedded in the concrete slabs which are about 8 inches thick. The roof is perfectly flat, which facilitates the distribution of heat in the oven and is considered superior to an arched roof. This type of roof has proved very satisfactory and is practically indestructible. The walls, which are constructed in the usual manner, are of brick. Coke fuel is used, the flue from the fire box entering at one corner, the out-take flue being situated in the opposite corner. The oven doors are of the vertical, sliding type and have been especially designed to overcome the disastrous effect of gas explosions which occasionally occur. The door slides on one side in an angle iron, *I*, Fig. 5, and is, therefore, free to swing out slightly. Any explosion or unusually rapid combustion in the oven merely creates sufficient pressure to push out the free side of the door, permitting the gases in the interior to escape. As soon as the pressure is relieved the door drops back into place by its own weight.

A very interesting type of car, Fig. 5, is used in the drying oven. It consists of a framework of steel I-beams thoroughly braced and riveted together. The trucks are not carried in journals of the usual type, but are fixed on axles which roll against the lower edge of the longitudinal beams as shown at *A*. This forms practically a roller bearing which requires no lubrication. The slot in which the axle travels is about 26 inches long, sufficient for approximately a 12-foot car travel. The general construction of this bearing is shown plainly in Fig. 5. Each wheel is mounted separately and the wheels are prevented from slewing by the framework of the truck. With a clean track one man can push this truck loaded to its capacity and there is never any trouble with the journals. The track is laid to a 3-foot gage.

Sand Storage

Sand for the use of the foundry is stored in four concrete bins situated adjacent to a spur track north of the main building. The bins are approximately 14 feet square and 10 feet high, the walls being 6 inches thick. A roof protects the contents from the weather. The sand may be unloaded directly from railroad cars into the bins and is shipped from the bins into the shop on the 24-inch industrial railway that connects all parts of the plant.

The cleaning department is situated in a separate building and occupies a space about 50 feet square. A complete sand blast outfit is installed, together with two 36 x 60-

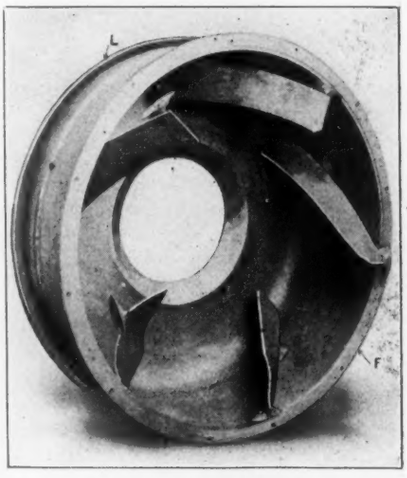


FIG. 3—SEMI-STEEL CONCRETE MIXER DRUM

inch tumblers and the usual equipment of grinders, saws, etc. The tumblers are placed in an enclosed room which keeps the dust confined to their immediate vicinity.

In many shops losses are expe-

rienced because the molders handle patterns much more roughly than is necessary. The Chain Belt Co. has given some study to this problem and has formulated a set of rules regarding the care of patterns. These rules are printed plainly, framed under a glass and are posted conspicuously throughout the foundry.

Care of Patterns

They are as follows:

1.—Rapping bars must be used in rapping plates only.

2.—The use of rapping bars in the center plates of gears and sprocket wheels is strictly forbidden.

3.—Hammers must not be used on either wood or metal patterns without the use of a hardwood block between.

4.—The teeth of gears or sprocket wheels must not be removed for any purpose whatever; extra teeth will be supplied by the pattern department if necessary.

5.—Each molder will be held responsible for any damage to patterns used by him.

6.—If a molder is given a pattern which is not in proper repair he must report the condition of it to the foreman before using it. Repairs must be made by the pattern department only.

In addition to the equipment mentioned in the foregoing, the shop is provided with a core oven similar in size and construction to the drying oven. A car of the usual type is provided for handling heavy cores and permanent shelves for small work are placed around three sides of the oven.

In addition to the 20-inch Mumford jarring machine, previously men-

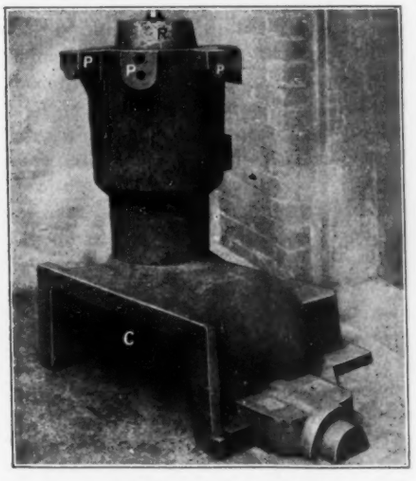


FIG. 4—ALUMINUM GAS ENGINE CYLINDER PATTERN

tioned, a 6-inch machine of the same type is installed in the core room. For general work, five squeezer machines and one roll-over have been furnished by the Arcade Mfg. Co., Freeport, Ill. The use of the Arcade molding machines has in many cases resulted in appreciable economies. For instance, by hand-molding it was possible to put up 100 molds a day using a gated pattern carrying eight small roller castings. With the machine a similar number of molds, each

FIG. 5—DRYING OVEN AND MOLD CAR

however containing 17 castings instead of eight, are made daily. On account of limited floor space the small machine molds are stacked.

The officials of the Chain Belt Co. include C. W. Levalley, president; W. C. Sargent, vice president and secretary; Donald Fraser, second vice president and general superintendent; F. W. Sivyer, third vice president; W. C. Frye, treasurer; J. W. Brown, assistant general superintendent, and C. E. McCampbell, foundry superintendent.

Hard Scrap for Soft Castings

By W. J. Keep

Question.—We make small, thin castings and we would like to know whether the use of shot iron hardens our mixture. How should shot iron be charged? We accumulate also, considerable white iron scrap and we would like to know whether this can be used without hardening our mixture?

Answer.—If your regular mixture produces castings sufficiently soft for your use the shot iron and thin scrap, when remelted, will serve the same purpose as return scrap consisting of sprues, gates, etc. The shot and thin scrap should be added to each charge in such proportions as will consume the daily production of this material. If the shot falls through the charge into the melted metal in the hearth it will do no damage as the shot will be sufficiently hot to melt when it reaches this section of the furnace. The prejudice against shot iron made in one's own foundry is without reason, as it does not become sufficiently oxidized to cause an excessive loss. A different problem, however, is presented in the use of purchased white iron scrap. This old material is of two kinds, namely, chilling and non-chilling. The fact that it is white does not indicate that it will take a chill. Makers of grinding machines of various types often find that the teeth and grinding edges, although perfectly white, are almost malleable and will not hold their edges. The use of car wheel scrap or a chilling pig iron will produce strong cutting edges. You can use a small amount of chilling scrap and a large amount of non-chilling scrap iron without affecting your mixture. As a matter of fact, it will have a tendency to improve it, but you must add a sufficient amount of silicon to increase the silicon percentage in this scrap to a higher point than that of your regular mixture. Iron of this kind will produce close-grained, soft castings, provided the silicon is sufficiently high.

An experiment of this kind should be conducted carefully, as your melter may not understand the softening effect of silicon. It might be advisable to use 50 per cent ferrosilicon which is charged in the cupola in a sufficient amount to increase your silicon content to the desired point. Malleable iron scrap can be used to advantage, but a smaller amount should be charged, as it is difficult to melt.

Medical Hints for the Plater

By Seymour W Rowsbar

BELIEVING that reliable information relative to the relief or cure of many ailments peculiar to electroplaters will be appreciated by those engaged in the various branches of the trade, the author dedicates the following to his fellow workmen. Each remedy or antidote has been successfully used by the writer or has been used by those personally known to him, and the efficiency of the treatment is vouched for. He wishes, however, to have it distinctly understood that he does not claim that all cases are susceptible to prompt cure by the use of these or possibly any other remedies. Common sense is a valuable asset when dealing with human ailments. Constitutional disorders often thwart any attempt to relieve external suffering.

Very few industrial occupations expose the workman to greater risks from corrosive influences of poisonous vapors, burns or other evils which have a detrimental effect upon the health and bodily comfort of the individual by their action upon the skin or mucous membranes, than does electroplating, coloring and finishing. Yet there are many men who have been engaged in these lines for a lifetime without experiencing any appreciable inconvenience or damage to health. We are not all so fortunate, however, but for various reasons we continue at the business and suffer from a multitude of aggravating ailments, either because of carelessness, necessity or physical derangements occasioned by disregard of nature's simple laws.

There are two fundamental points which should be ever paramount in the minds of men engaged at the trade, when considering health. While worthy of attention by all mankind, we should be especially attentive to the proper ventilation of the workshop and home and the care of the digestive organs. The proper ventilation of the shop should receive the first attention of the foreman plater. It is indeed a marvel that some men live six months in the dirty, dingy corners called plating shops, to be found in some of the large cities. Many are poorly ventilated, with floors, or slats of wood, reeking with a mixture of acids and alkalies, tobacco juice, etc., constantly affording a source of ill-smelling vapors in addition to those arising from the dips and baths, no attempt being made to improve conditions or to secure ventilation. If ordinary means should fail to relieve the sufferings of those at work in such surroundings, it would not be surprising. These conditions do not exist extensively in industrial plants today, but are to be found, nevertheless.

Damage of Wet Floor

A wet floor will at least cause tired, aching feet, if eventually it does not cause rheumatism. For the plater who does not have to move about rapidly, or is required to stand on a damp floor, the wooden shoe affords excellent protection. After one becomes accustomed to this stiff and somewhat unwieldy footwear, the wooden shoe is very comfortable and safe. Not only should the workman attend closely to the ventilation of the workshop, but his sleeping hours should be spent in well-aired apartments. Fresh air inhaled while the body is at rest is equally as essential as when active, and possibly more damage is entailed by breathing impure air while sleeping than is occasioned by dust or vapor during working hours in the average modern shop. Drink plentifully of pure water and abstain from the use of tobacco and alcoholic liquors. In warm weather avoid foods which have a tendency to heat the body. Constipation is especially dangerous to the plater, and the individual who chronically is subject to it should awaken to the fact that he is suffering from a serious complaint, which can be relieved only by energy and perseverance on his own part. His first efforts should be to remove the cause. To remedy the evil it will be necessary, perhaps, to effect a radical change in his personal habits quite independently of medicines. Then comes attention to diet. It is well to have a variety in the diet, fruits, vegetables, bread and meat, but it is not desirable to include digestible articles which are eaten with avidity, for it must be remembered that the food must be digested in the stomach before reaching the intestines and to derange the stomach by a diet improper for it is to promote constipation by favoring dyspepsia. Next, the plater should indulge in some sort of exercise which interests and amuses the mind and takes him into the open air.

Cyanide poisoning is possibly the worst condition brought about by contact with electroplating solutions. Its effects, on some systems, are destructive, while others seem to be immune from any external influences of this powerful poison. If symptoms of cyanide poisoning become very pronounced in from two to three months after engaging in the plating business, our advice to the person would be to begin a thorough constitutional treatment and if no improvement is noted in a reasonable time, to seek a change of occupation. The individual suffering from cyanide poisoning is not only miserable himself, but if the arms and face are affected, he is not altogether a pleasant person to work with. Frequently, the odor of cyanide is very noticeable from those who perspire freely. In

some cases, if the sufferer consults a physician, the eruption is said to be eczema in a unique form, or prickly heat, and in one case which came under my notice, the attending physician was positive that the sores were the result of insect bites. In my experience, the worst cases have been among men whose systems were deficient in iron and a treatment including iron has proved beneficial. Cheap alkali soap should be avoided and when soap is necessary, use pure castile sparingly. Green onions, tomatoes and fresh air are wonderful aids in treating cyanide poisoning. We recently heard a plater of 25 years' experience tell a younger man that an application of hot water was the only thing beneficial in relieving pain from cyanide sores upon the hands, which are the results of cuts, scratches, etc., in contact with cyanide solutions. I have found but little comfort from the use of hot water, the sore invariably continuing to maturate until the completion of the core, and then the inflammation subsides and intense irritation follows.

Treatment of Cyanide Eruptions

The average man will not use even ordinary care until after he has had a real experience with cyanide sores, and to those at least I trust the following method will prove of value. When a cut, scratch or abrasion of the skin is received in any way upon the hands, wash them in clean water until the bleeding ceases; then place the hands in a solution of sulphuric acid, 1 part, and water 4 parts, allowing them to remain as long as good grit and nerve will permit, or the solution may be poured over the wound if more convenient. The treatment is more or less severe the first time, but after a few cuts are thus treated, the ordeal will become easy. The treatment should continue for at least one minute, or until the cut is clean and quite white. Then wash in clean water and wrap in a clean cloth powdered with boracic acid. After a few hours, abrasions thus treated are not materially affected by contact with cyanide. I have in mind a case where an apprentice received a wound upon the hand by having the member caught between the armature and magnet of an old style plating dynamo, the skin being entirely removed from the back of the hand, leaving marks of the armature wire upon the flesh. The injury did not cause a great flow of blood, but under ordinary treatment would have proved a dangerous wound. The lad possessed considerable pluck and, having implicit faith in his foreman, obeyed his instructions and plunged his hand into an acid mixture as previously given; after washing it, a few drops of olive oil were poured over the parts and the latter properly bandaged. Then the lad proceeded about his usual labors instead of going home. No pain or soreness was experienced and in four days the wound healed sufficiently to allow the dressing to be removed. A physician would never prescribe such treatment, because it is too drastic for general use. But for the plater who is more or less familiar with the use of acids, it is a sure and handy remedy to employ, if mixed with water and common sense. Cuts treated in this manner will not result in cyanide sores.

Relief for Cyanide Sores

Cyanide of potassium is almost as deadly as prussic acid when taken internally, and if a considerable quantity is absorbed no measures offer much promise of recovery, as either chemical causes paralysis of the heart and of the respiratory organs. A competent physician should be summoned immediately, while the coldest water obtainable should be poured over the head and down the spine of the sufferer and he should be removed to a place where plenty of fresh air is available. Vomiting should be promoted by giving the patient warm water containing a teaspoonful of mustard. Meanwhile, ammonia should be held near the nostrils. As soon as the person seems capable of breathing, strong coffee containing a little whisky or brandy may be given as a stimulant and the limbs should be rubbed vigorously with a coarse towel to induce circulation. Speak to him frequently in order to prevent him from lapsing into unconsciousness.

In case a physician is not obtainable, the following solution may be prepared and carefully administered: Ten or 15 grains of green vitriol dissolved in two ounces of water; to this add one half teaspoonful of subsulphate of iron solution and enough caustic soda to make a liquid somewhat alkaline in reaction. One-half this mixture may be given at once.

When cyanide sores appear upon the arms or elsewhere on the body, except the hands, they seldom become deep enough to contain a core, but usually cause intense agony. The irritation and pain may be relieved by freely applying camphorated oil. Add three ounces of camphor to one pint of olive oil and dissolve by slow heat. These proportions make a mixture slightly stronger in camphor than that obtained from a druggist, and while it causes some irritation when first applied, relief from pain is soon afforded. In mild cases and in the first stages, the following will be found beneficial: Zinc oxide, one-half ounce; zinc carbonate, 30 grains; glycerine, one-half ounce, and lime water to make one-half pint. It has a drying effect and relieves the irritation.

Equal parts of camphor solution and glycerine, mixed and applied to the parts, may be used with good results, especially if the skin is disposed to crack at the finger joints. My attention was recently called to a case where a man, scouring work for plating, had partially supported his body by allowing one knee to rest against the side of the scouring tank. The side in question was saturated with cyanide copper solution dripping from articles removed from the copper bath to the rinse water. The trousers had become wet at the knee and the man allowed the condition to continue without a murmur until the foreman inquired as to the cause of his lameness. Upon examination a sore 3 inches in diameter was found upon the knee. The joint was stiff and very painful. A poultice made from a mixture of linseed meal, four ounces; olive oil, one-half ounce; and boiling water, 10 ounces, was applied. The inflammation was soon arrested and the sore was then painted with a weak solution of iodine, followed by an application of sweet oil. After the second day carbolized vaseline was used instead of the sweet oil and the joint was in normal condition at the end of one week.

Protecting Wounds

For sores which are indisposed to heal, the following will be found valuable: Pure lard, 5 ounces; olive oil, 5 ounces; white wax, 2½ ounces; spermacetti, 2½ ounces; oxide of zinc, 2½ ounces and powdered gum benzoin, one half ounce. Platers afflicted with cyanide sores should exercise very freely in the open air to induce a proper circulation of the blood, as invariably the circulation becomes sluggish when thus poisoned. A Turkish bath often proves beneficial or a common bath in carbolized or borated water. Platers who are never afflicted with cyanide sores are sometimes troubled with chapped hands, especially in cold weather. The following will be found an excellent remedy: Make an emulsion of carbolic acid, 30 grains; glycerine, three ounces, and the yolk of one egg. Rub a small portion of the afflicted

parts and wear a pair of old gloves at night. The natural tendency of a flesh wound is to heal and any failure to heal is evidence either of some constitutional taint or the entrance of foreign particles or substances into the wound. The chemical poisons of various kinds are frequently introduced carelessly or ignorantly into wounds, which would otherwise heal without difficulty. In some shops, it is a common practice to apply shellac to cuts. This is a very dangerous treatment. Numberless cases are on record of serious poisoning from shellac applied to flesh wounds. While it is not the best practice to exclude the air from a cut or wound, it is sometimes necessary or desirable to do so. In such cases liquid court plaster is very satisfactory and may be made of flexible collodion, ¾ ounce, and ether, ¼ ounce. When dry it will not wash off.

Treatment of Scalds

When the arms are scalded by hot cyanide copper or brass solutions, potash, lye, etc., wash them with clean cold water; then apply a saturated boracic acid solution, followed by olive oil. Fire burns, when dry, may be dressed with cloths wet with bicarbonate of soda solution. If the flesh is wet, apply the soda dry and cover with a wet cloth. Polishers will find an excellent remedy for flesh wounds upon the hands in carbolated vaseline. A solution of two ounces of sugar of lead and one quart of water is especially good in cases of inflammation. Acid burns of the eyes are always more or less frequent in plating shops and often the source of great discomfort. Acid burns of the eye should on no account be treated with alkaline solutions, but should be liberally bathed in clean, warm water and milk, the fluid being allowed to run over the eyeball freely. The washing should be followed by the application of a few drops of cocaine hydrochloride, slightly warmed, after which the eye is annointed with pure castor oil and the eye covered with a piece of lint, wet in warm water, the lint being held in place by a bandage. This should be repeated two or three times a day. A 2 per cent ointment of cocaine hydrochloride and vaseline applied to the eyelid affords great relief and should be applied at bedtime. Cyanide copper solution or lye causes the eye to become badly inflamed and painful, and a very simple and efficient remedy consists in washing the eye with a saturated solution of boracic acid and water. A saturated solution of boracic acid is also wonderfully effective in curing a sore throat when used as a gargle several times a day. It works like magic.

Acid Poisoning

Cases of poisoning by acids in the plating room are rare, but it will be well to remember that in all cases the first object of treatment is to neutralize the acid by causing it to combine chemically with other substances such as soda or potash, so as to deprive it of its corrosive power. It is, of course, improper to give the strong alkalies, since these are themselves corrosive. A teaspoonful of washing soda stirred in a cup of water, or as much soap in water, should be given at once; this should be followed by or by one or two glasses of milk.

TROUBLES OF THE ELECTRO-PLATER

Discussed by Practical Men

How to Clean Aluminum Ware

I wish to obtain some solution which can be used to remove grease and foreign matter from aluminum ware.

A hot, 10 per cent solution of bicarbonate of soda saturated with common salt will give the aluminum a good surface. Immerse the articles and allow them to remain in the solution for about a quarter of an hour. Then remove and brush them, following this operation by another momentary immersion in the solution. The articles are rinsed in cold water, passed through clean, hot water and dried. This produces a matte surface. Dilute caustic potash will clean the surface without producing the matte.

Oxidized Silver Finish

We would like to have a formula for a solution which will oxidize silver, the gray finish being preferred. We have several oxidizing solutions, but the silver is left with a reddish tinge.

The oxidizing solutions in general use by finishers today produce a blue-black color, as for instance, the liver of sulphur solution. The color produced by this solution has a tint of blue, regardless of any treatment which may be given the solution. From ¼ to 2 ounces of liver of sulphur to 1 gallon of water should give you good results. In producing the gray tone do not use rouge on the wheel or brush. A circular tampico brush to which is applied some *F F* pumice stone in a moistened condition will relieve the portions required gray. Some platers slightly copper plate the silver before oxidizing. This method is liable to give the work a tinge of red if not carefully carried out. Any reliable oxidizing solution will produce a black surface and the gray is obtained by mechanical means. Another very reliable solution follows: In one gallon of commercial muriatic acid dissolve 2 pounds of white arsenic by heating the mixture. When the arsenic is entirely taken up add 8 ounces sulphate of copper and stir well until all is dissolved, then allow it to cool. Use the solution cold and if after using some time the color produced is not dark enough, replenish with arsenic dissolved in muriatic acid.

The following solution will produce a beautiful blue black which will permit the use of a wire scratch brush and pumice in producing the gray effect: Double nickel salts, 4 ounces; hyposulphite of soda, 2 ounces; liver of sulphur, 4 ounces, and water, 1 gallon. Perhaps you are using a gun metal solution for the gray finish, and if so, we advise avoiding those containing carbonate of iron, as its use is productive of brown tones. By using a solution of 2 ounces of liver of sulphur and ½ ounce of 26 per cent liquid ammonia to each gallon of water, an excellent black will result. To produce

the French gray, use a fine steel wire scratch brush instead of brass and apply wet pumice stone with a rag to the wheel. Brush lightly, using a colorless lacquer and be certain that the lacquer used has not become contaminated by any foreign substance which might give the work reddish tone. Any of the solutions mentioned should produce an excellent gray upon sterling silver or silver-plated ware. All are in general use by the trade, and represent the most reliable solutions for this particular line of work. Do not use the solution too strong; bring the color up slowly and you should have no further trouble.

Filling Pin Holes in Gas Engine Cylinders

We desire information regarding some solution which can be used for filling up pin holes in gasoline engine cylinders. The holes are no larger than a pin head, but are sufficient to let the water into the combustion chamber from the jackets. On account of the complicated construction of the cylinder heads, the holes are not accessible from either the outside or the inside so that resort must be had to some solution that can be run into the water jacket to fill up the pin holes. A solution of sal-ammoniac has been suggested, which might close the holes by rusting the iron. A solution that does not attack the iron would be desirable, as many of the holes are not discovered until the castings are machined.

Thousands of gasoline engine cylinders are annually relegated to the scrap pile for no other reason than the trouble mentioned above. Sal-ammoniac treatment is unsatisfactory and necessitates much extra labor. Metallic fillers or cements are now obtainable, which give excellent results where the part to be treated is accessible. In the present case, use the following as directed and no further difficulty from this source will be experienced. If the holes are discovered before the cylinder is assembled, close up all the openings in the water jacket except one. Slightly oil the surface of the combustion chamber if it has been machined so as to avoid possible soiling. Mix one quart of silicate of soda (water glass) with 3 quarts of warm water (not hot) and pour this solution into the opening. Then apply sufficient air pressure to force the solution into the holes and crevices. Keep under pressure about 5 minutes and pour out the surplus solution and set the cylinder aside for 24 hours. If the combustion chamber shows any indication of the solution having oozed through, the surface should be wiped out before setting the cylinder aside. At the expiration of 24 hours any regular operation may be proceeded with or the cylinder may be tested. If the cylinder has been assembled before the imperfection is discovered, fill the water jacket with the solution, start the engine and run until the solution boils, then allow it to cool somewhat and remove the solution from the water jacket, permitting it to remain quiet for several minutes. After the jacket is filled with water in the usual manner, the engine is ready for use. The silicate of soda forms a hard, glass-like film over the surface and corrodes all holes and crevices, filling them permanently. It is not affected by heat or water and neither the expansion nor contraction of the metal causes the hole to re-open. This method has been in use by one of the largest manufacturers of gas engines in the country for the past three years. Not one cylinder thus treated has ever given trouble.

Lining for a Nickel-Plating Tank

Two years ago we lined our nickel-plating tanks with a mixture of pitch and tar applied with a broom. This summer the lining has come off and portions are found daily floating upon the surface of the solution. These pieces are very brittle and spongy and the tanks are leaking through the seams. What course would be advisable to procure a good lining and stop the leaks?

Judging from our personal experience, we would advise making the tanks water tight before attempting to reline them. It is poor policy to depend upon a lining of this character to procure a tight tank. Remove as much of the old lining as possible, and iron the remainder into the wood, but avoid burning. Cover all seams and corners with cheese cloth or burlap or cover the whole inside in this manner and tack at the top. By laying the cloth on the soft pitch it will remain in position. Then turn the tank on its side and apply a coat of pitch tempered with coal tar to make it less brittle. This coating should be from ⅛ to 3/16 inch in thickness. Spread it uniformly over the entire side and work well into the corners, after which sprinkle some moderately fine sifted sand which has been made very hot, over the surface and roll it into the pitch by means of an iron shaft or piece of pipe. When cold, the excess of sand may be removed by brushing with a broom. The entire surface of each side, end and bottom is covered in the same way. A tank, properly seasoned and lined in this way, will remain in excellent condition for years.

Carbonate of Copper

On one or two occasions I have attempted to make carbonate of copper. I succeeded in getting the carbonate, but it was of poor quality. I would be pleased to receive any information which would assist me to get better results.

To make carbonate of copper, procure two receptacles for the solution. If you wish to make 50 or 75 pounds at one time, two clean whiskey barrels will answer, or for a small quantity, use crocks. The barrels must be clean. Never use benzine barrels or those used for similar purposes. Perhaps this is why you did not succeed. In one barrel dissolve a known quantity of sulphate of copper in as small amount of water as possible. It is well not to attempt more than one-third of a barrel at one time. Boil the water in order to obtain a saturated solution. In the other barrel dissolve 2 pounds of sal-soda for each pound of sulphate of copper, previously dissolved. This is also affected by boiling and the quantity of water should be kept as small as possible. Be sure that all the crystals in both barrels are dissolved and while the solutions are still quite hot, begin adding the soda solution to the copper solution in very small quantities, stirring during and following each addition. Owing to the liberation of carbonic acid gas the precipitation should be cautiously proceeded with in order to avoid waste. When the precipitation is complete, the evolution of gas will cease. Then stir thoroughly and allow to settle. If the two solutions are hot when mixed, the carbonate of copper produced will settle very rapidly and compact, while if the solutions are merely warm the precipitate will be spongy, will settle very slowly and is not pleasant to use. When the precipitate has settled, which should require but a few minutes, siphon off the clear liquid and throw it away. It is sulphate of soda, and is of no value. Fill the barrel with hot water again, stir thoroughly, then allow to settle and siphon off as before. Repeat this washing until the water contains no trace of soda. Then give at least one washing in clean, cold water, allow a little longer time to settle, 2 or 3 hours if possible, and then siphon off the water and empty the carbonate upon a strainer made of factory cotton of several thicknesses of cheese cloth tacked to a frame. Allow the mass to remain over night and the plastic carbonate of copper will be ready to place in crocks for further use. It should be kept moist. Care is required to dissolve all the sulphate of copper before adding the soda and also to precipitate all the copper, otherwise sulphate of copper will be introduced into the plating bath.

Molding a Water-Cooled Gas Engine Cylinder*

A Description of the Methods Pursued in An English Foundry With Hints on Making and Assembling the Cores

By J D Robinson

MY PURPOSE is to describe the methods adopted at our works to secure sound and clean castings. The cylinder under consideration, Fig. 8, is one of the four which go to make up a 350-horsepower gas engine. The diameter of the bore is 17 inches, and the overall length 5 feet, 1 inch. By way of prefatory comment, I may point out that to the uninitiated and inexperienced certain difficulties in the making of patterns and core boxes and in the making and casting of the mold may appear very formidable, whereas to the less critical these difficulties will be non-apparent. That there are serious obstacles to be overcome will be well known to one who has had experience in this class of work, but he knows equally well how to avoid the pitfalls ever awaiting the unwary.

As a result of exhaustive experiments, we have adopted the following method, which is productive of the best results. There will be noted in Fig. 8 a variation in the thickness of the metal at the point where the flange is connected with the inner and outer walls of the cylinder, and also at the opposite end, where solid blocks are cast in to receive the studs for attaching the end cover. During machining operations these two points have been found to exhibit a spongy nature, and have proved the most prolific source of trouble, which has been overcome by the use of chills and a suitable mixture of metal.

How the Mold is Made

The mold is made in dry sand. It is made on the flat and placed on end for casting. The valve box end, being the part where the explosions take place when the engine is at work, must be perfectly sound; therefore, that end is cast down. To the other end, which is quite plain and easily extended, a rising head is attached to collect the dirt, etc. A full pattern is used for the outside, and the center or body core is struck-up on a barrel in loam. The jacket core is made in two half-boxes, which will be described later.

The pattern, Fig. 1, is jointed along the center line. At the plain end a core print, *C*, of the same diameter as the body core is provided, whereas at the other end the core print, *D*, is of the same diameter as the jacket core which is carried through the end of the casting and requires a bearing. To provide a bearing for the body core at this end the internal diameter of the jacket core and the external diameter of the body core are made to correspond. The print, *E*, carries the part of the jacket core, which extends around the valve box, the prints, *F* and *G*, being the other points at which the main jacket core has a bearing on the outside.

Prints *H* and *K* carry the valve box cores, the remaining prints being merely for small local cores. The enlarged part, *L*, forms the rising head. A definite method of molding, coring and pouring having been decided upon, the actual molding is now a very plain and simple matter, requiring no special skill beyond what should be possessed by a good molder.

The method of pouring is as follows: The metal is dropped from the top, four runners 1¼ inches and ½ inch, which are spaced equally around the body core, being used. As this

*Presented at the annual meeting of the British Foundrymen's Association.

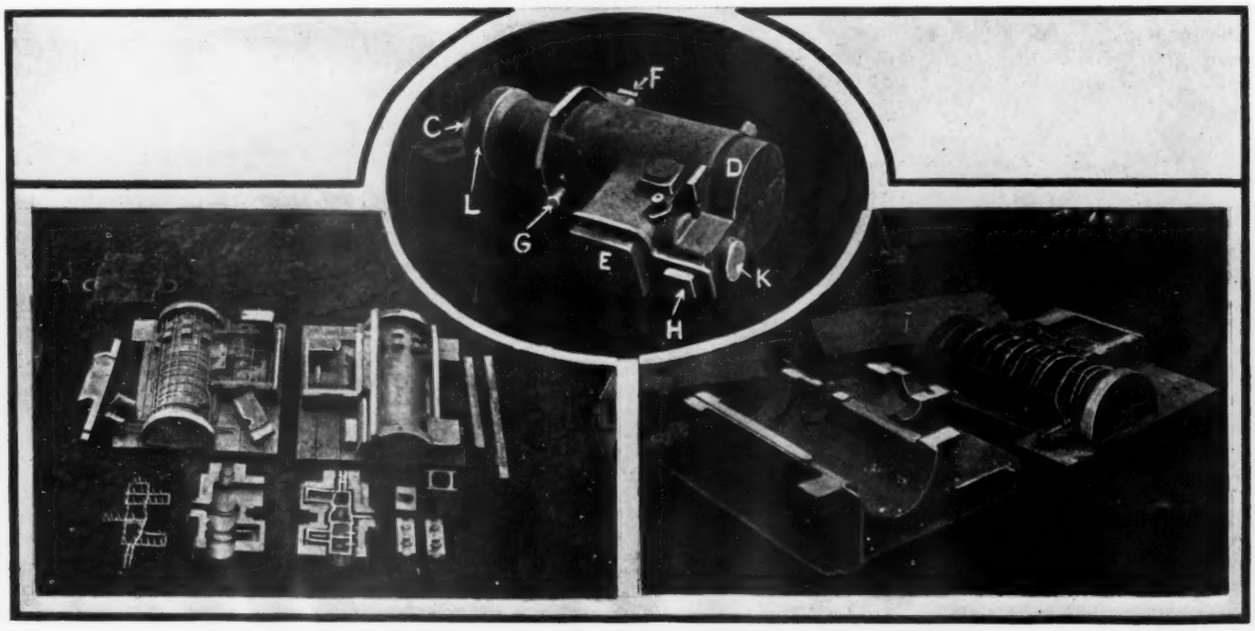


FIG. 1—PATTERN FOR WATER-JACKETED GAS ENGINE CYLINDER

FIG. 2—CORE BOXES FOR THE CYLINDER AND VALVE

FIG. 3—VENTING THE CORE WITH WOOD-WOOL BANDS

particular cylinder is rather long, a few hundred weights of metal are run in at the bottom to form a cushion and to prevent the metal from cutting the jacket core where it drops. This is done by means of a down runner at the side, which must be provided for in the course of ramming the bottom part of the mold. A riser is taken from the flange and another from the head.

Before drying, part of the sand over the prints for the jacket core at the end, and the valve box in the top half, are cut away to facilitate stopping-in around these cores when the mold is closed. The small cores are set while the mold is green, and are dried in position.

Fig. 2 shows the method of preparing the core boxes. The small box in front is for the valve box. This core is made in halves in oil sand, is strengthened with cast iron grids and is jointed when dry. For the main jacket boxes a flat bottom is prepared, and on it is placed a block of the form assumed by the thickness of the metal around the body core and valve box. The box ends are made to follow the thickness of the jacket core required, strickles being made the full length to work on these ends and to strickle off the sand to the required shape. At the point where the valve box joins the body it is necessary to have pieces worked to the required shape, as shown, and used loose. These cores are made in oil sand and are strengthened by loose irons, which are easily removed when the casting is being cleaned.

The vents in these cores are formed by placing wood-wool bands in the center of the thickness of sand during ramming. These all have a connection with the parts which have a bearing on the outer core prints. In the course of drying, these bands are more or less charred and form passages for the free escape of gas. After the cores are strickled off to the required thickness, the loose parts of the box are removed and cast iron plates are set along each side to support the core while being dried. The space between the plates and the rounded part of the core is filled with floor sand and is struck-off level. On the top of this is placed the cast iron plate on which the core is carried for drying, the whole being clamped together and turned over.

After being dried, any variation in the cores is dressed off by rubbing with a piece of emery stone, after which the whole is given a good coat of blacking. It might here be said that we find it necessary when using oil sand cores to allow ⅛ inch in 9 inches for shrinkage. The connections with the vents can be seen in Fig. 4 on the finished cores.

FIG. 4—THE FINISHED CORES

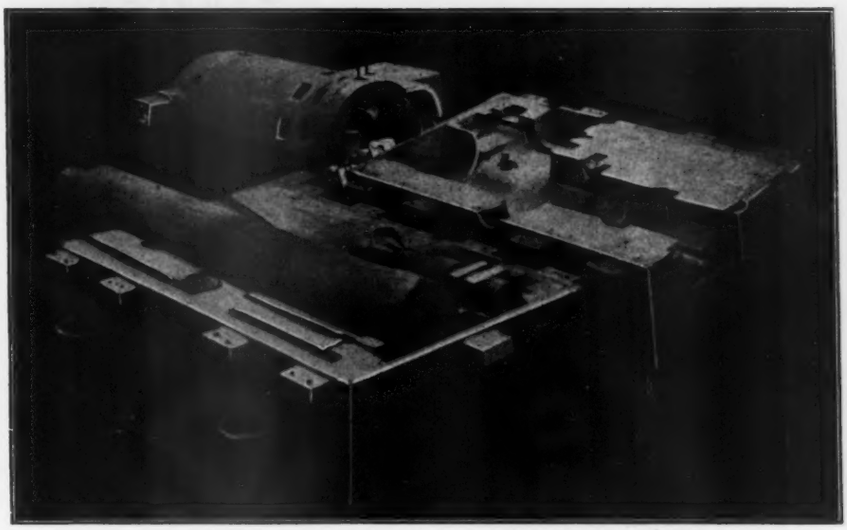


FIG. 5—SETTING THE CORES IN THE TWO HALVES OF THE MOLD

The remaining core is that of the body. This is struck-up in loam on a barrel in the ordinary way, except that provision is made for chills, which are placed opposite the two thick parts of metal in order to produce an equal rate of cooling and to prevent spongy or drawn places. These chills are made 6 inches wide and 1¼ inch thick in six segments, each of which is ⅝ inch short of one-sixth of the diameter required. The spaces between them are filled with loam, and allow for the contraction of the casting, so that the chills are easily removed when the casting is being cleaned. The core is made of such a length that it extends about 1 foot beyond the end of the flask in order to project well above the runner box when casting.

In assembling, the first core to be set is the bottom half of the main jacket core. This rests on the prints, *D*, *E*, *F*, *G*, Fig. 1, but in addition to these, two double studs are placed under the end nearest the flange, as the two side cores are not sufficiently strong to support the weight. When this is set, Fig. 5, there is a bearing at each end for the body core, which is next placed in position. This core is inside the flask at the bottom, packings being placed between the barrel and the flask-end to support the weight when the mold is set on end. The space at this end of the core is rammed with sand, a hole being left through the bottom of the box to take the vent from that end of the jacket core. At the other end a tube is connected with the vent and is carried through the side of the box.

The valve box core is then set and the other half of the main jacket core is lowered into position. Pieces of clay to try the space left for

metal are placed on the cores and the top part of the mold is closed over. When all thicknesses have been ascertained, studs similar to those mentioned in connection with the bottom part are placed on the jacket core and the mold is closed.

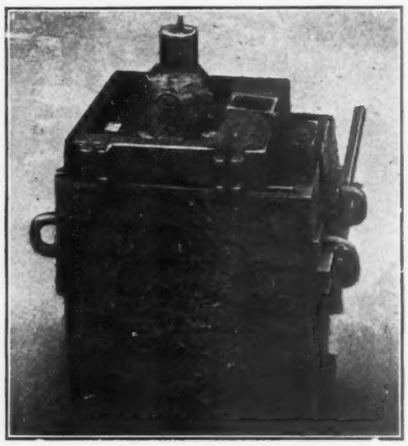


FIG. 6—THE MOLD ARRANGED FOR POURING

The open spaces over the prints are rammed-up with sand, the vents being taken off in the same manner as in the bottom part and the whole is securely bolted together.

The mold is then turned up on end and is lowered into a pit for casting. A large runner box is then set and a separate box for the riser from the flange. Plugs are placed over the runners and riser around the body core, and a piece of tin is placed over the down runner on the side. When casting commences, this tin allows a certain amount of metal to be poured into the runner box before it is melted, and thus prevents any dirt from flowing into the runner. After several hundred pounds of metal have been allowed to run into the bottom and the runner box has

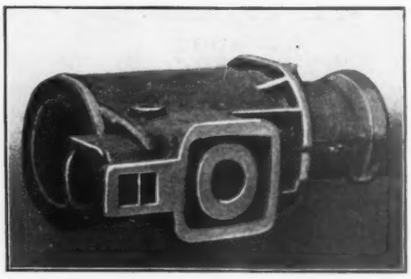


FIG. 7—THE CASTING READY FOR THE MACHINE SHOP

been well filled, the plugs over the other runners are drawn off. When the mold is filled the riser plug is removed and the ladle is taken to the riser from the flange, metal being poured into it to feed the thick part.

As soon as the metal is set the core barrel is withdrawn in order to assist the cooling of the inner walls of the cylinder, which are of a thicker section than the outside. The flask is then turned over flat, and the bolts through the lugs are eased to allow for the expansion of the flask, as otherwise there is a danger of the lugs being broken off. Fig. 7 shows the finished casting ready for the machine shop.

The Peterson-National Co.

A consolidation of the National Core Oil Co., Buffalo, and the foundry department of the T. J. Peterson Co., Chicago, has been effected and the merger is known as the Peterson-National Co., with headquarters at Buffalo and Chicago.

The National Core Oil Co. was organized at Painted Post, N. Y., about four years ago and during the past two years a new plant and warehouse were erected at Buffalo where the works are now located. The T. J. Peterson Co. has been engaged in the manufacture of core compounds and core oils since 1905. In addition to the main office, branches will be maintained at Cleveland, New York, and San Francisco and representatives will be appointed for the Canadian and other foreign territories.

The Peterson Co. has engaged in the manufacture of dry compounds, partings, as well as core oils, while the National Co. specialized in the latter product. In the near future a general line of core room supplies will be manufactured. All oils and compounds shipped to the trade are subjected to chemical analyses and physical tests, extensive departments being devoted to this work.

The officers of the company are as follows: T. J. Peterson, president and general manager; James A. Drake, vice president; Henry A. Bull, secretary and treasurer; H. S. Peterson, manager of the Chicago plant and George Burman, manager of the Buffalo plant.

Electric Furnace Reactions

The chemical action that takes place in an electric furnace during the refining of steel results in the dephosphorization and desulphurization of the bath, according to the statement made by Cecil Myers in a paper read before the Manchester (Eng.) Association of Engineers. The action takes place in two stages. In the first, which is the oxidation period, the carbon, silicon and manganese are oxidized and in the second, which is the deoxidation period, the metal is dead-melted, and the sulphur is eliminated. The first action is brought about by adding to the charge, certain quantities of lime and oxide of iron, which, under the influence of the high temperature, oxidize the carbon, silicon and manganese, and remove the phosphorous as calcium phosphate. After this operation, the slag is removed from the bath, and further quantities of lime and sometimes carbon, are added. This is the second stage, when the sulphur passes into the slag as calcium sulphide which is not soluble in the bath.

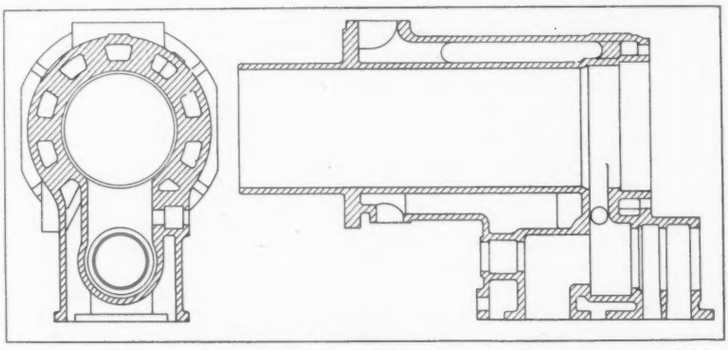


FIG. 8—SECTIONS OF THE WATER-JACKETED GAS ENGINE CYLINDER

In the open-hearth furnace, calcium sulphide would be readily oxidized into calcium sulphate which would combine with the iron to form sulphide of iron, carrying the sulphur back into the steel. In the reducing atmosphere of the electric furnace this change cannot take place, so that it is possible to remove the sulphur to almost any extent. In reply to a question as to whether good steel castings could be produced by the electric furnace, Mr. Myers stated that they certainly could, but they would be more expensive at present than the product of the open-hearth furnace, and probably not much better.

The Russel Wheel & Foundry Co., Detroit, has placed an order with the Rockwell Furnace Co., New York City, for a furnace for heat treating automobile forgings.

Typical Cast Iron Uses and Applicable Tests*

The Various Uses of Gray Iron Sections in the United States with Suggestions for Additional Quality Tests

By John Jermain Porter

AMERICAN foundry practice has made great progress in passing from the empirical stage to that of scientific control. A most important feature, the use of chemical analysis as a basis for mixing irons, is now practically universally adopted, but much still remains to be done both in the more efficient use of chemistry and in the adoption of other scientific methods of control.

It is now becoming quite widely recognized that chemical composition is not the only factor determining the properties of cast iron, but, although the importance of structure is known, the methods of metallography have received very little attention from foundries and users of castings. It is true that investigators have used the microscope on cast iron with valuable results, but this method of control has not yet been generally taken up in practice as in the case of steel. The two reasons which apparently account for this neglect are first, the fact that foundries, being operated in smaller units, have as a rule less technical skill available at each individual plant; and, second, that the more complex structure of cast iron makes the interpretation of its microstructure much more difficult.

Presence of Oxygen and Nitrogen

The theory that oxygen and nitrogen may be present in cast iron and are accountable for some otherwise inexplainable phenomena is gaining ground among practical foundrymen, and means of eliminating these elements are being widely adopted. Greater care is being given the cupola process, and the use of ferro-manganese, silicon, vanadium and titanium as deoxidizers is rapidly increasing. Ferro-alloys are also rather extensively used to correct the composition of the iron in the ladle.

Since cast iron is used for a wide variety of purposes, it is obvious that the properties by which its value is measured and the tests to which it is subjected should be different for each class of castings. Hence it is necessary to consider each class separately. It is true that current practice does not as a rule adequately recognize this fact, and almost the only test which is commonly applied is that for transverse or tensile strength, although this property in many or perhaps the majority of cases is not of chief importance.

The succeeding portion of this paper will discuss some characteristic American uses of cast iron, the properties needed, recent progress in meeting these needs, and the tests necessary to define the desired properties.

Machinery Castings

A large percentage of machine parts are made of cast iron, which material is especially adapted for this use on account of the ease with which it is cast and machined into the desired shape. The more important properties desired in machinery castings are softness, strength, and a fine grain-structure, in addition, of course, to freedom from visible defects such as blow-holes, cracks, shrinkage cavities, etc.

It is an easy matter to make soft castings, but to get the combination of easy machining properties, strength, and close grain, as demanded by some users, has proved a difficult proposition to many foundries. Especially is this true as to closeness of grain and the ability to take a high polish, which is so desirable on many finished parts. The solution has been reached in various ways. The use of charcoal iron is one method, satisfactory except from the standpoint of cost. Certain brands of coke irons are found to give greater strength and closer grain for a given softness than others, and the knowledge of such mixtures is a valuable asset to the practical founder. Another method is found in the use of steel scrap in the cupola mixture, making the so-called semi-steel, which gives a closer grain-structure and considerably more strength without material change in composition. The treatment of the metal with certain ferro-alloys has also been found advantageous in this connection.

Hardness, Strength and Grain Size

The buying of machinery castings would be greatly simplified if definite limits of hardness, strength, and grain size, could be specified. Satisfactory methods for testing hardness are found in the drill test and the Shore scleroscope, most of the various other proposed methods being too cumbersome for commercial use. The drill test, simulating as it does actual machining operations, gives the more reliable results, while the scleroscope possesses the advantage that it can be used directly on the casting without in any way injuring it.

For testing the strength of cast iron there are available the ordinary transverse, tensile and compressive tests, the first of which is, in the opinion of the writer, preferable. In the testing of strength (and hardness also) it must be remembered that the properties of cast iron depend in part upon the thickness of the section, and hence that, in cases where it is not possible to test the casting itself, the test piece should at least approximate the section of the casting. Probably three standard sizes of test bars could be selected, to represent the three classes of light, medium and heavy castings. The broken ends of these bars could be then used for the drill test to determine hardness.

Test for Grain Size

For grain size there is no practical test available; a serious lack, as in many cases this property is of the greatest importance. Possibly something might be done with a planimeter used on a microphotograph of standard magnification; a rough test, of value in some cases, can be made by comparing the fracture of a broken test bar with a scale made of previously broken test bars of varying grain size.

The freedom from blow-holes and other casting defects is best determined by ocular inspection. Unfortunately there is no method of inspecting the interior of the casting without destroying it, and while the tendency of the iron to shrinkage, blow-holes, etc., can easily be tested, such tests would be of doubtful utility since these troubles are frequently, if not usually, due to faulty molding and pouring.

Cast iron is still very generally used for hydraulic work, on account of the ease with which it is formed into shape, although there has been some attempt to substitute steel for very high pressure. The properties desired in the metal are practically the same as in the preceding case, except that they

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stand in a different order of importance, close grain and freedom from shrink-holes and spongy places being the first consideration. Much the same means are used to obtain the combination of density, strength and the ability to machine easily, but as the importance of density is greater in this case, the use of special means, such as charcoal irons, steel scrap and ferro-alloys, is more frequent.

The most direct and satisfactory test for hydraulic work is to subject the casting itself to some specified hydraulic pressure. In many cases, however, the casting cannot be so tested until a good deal of expensive machine work has been done on it, and in this event it seems advisable to specify the strength and hardness tests previously described. The hardness test should be used in any case, as the bursting strength does not, of course, give any idea as to machining properties. A test for grain structure would be especially valuable in connection with this class of work.

Electrical Machinery

For parts where high electrical permeability is of prime importance, cast iron has been largely displaced by steel, but in the majority of cases it still holds its own on account of the greater ease of forming. The permeability of cast iron, although always low as compared with that of the purer forms of iron, can be considerably improved by keeping the manganese very low and the silicon quite high. In practice, however, not much attention is usually given to this property, since the greater number of castings are used in parts of machines not carrying the magnetic lines of force, and hence having requirements not different from ordinary machinery castings.

In electrical castings a permeability test used in conjunction with strength and hardness tests should be sufficient to define the quality of the material. Since permeability probably bears a fairly close relation to chemical composition it might be possible, although certainly less satisfactory, to specify analysis in place of permeability direct.

A large variety of castings must be classified as heat and chemical-resistant; the best known examples are probably ingot molds and grate bars. Only a few foundries are giving attention to producing castings of these special properties, and there is but little generally available information. Grate bars, for example, are ordinarily made of the cheapest possible mixture irrespective of its quality as regards service. In the case of ingot molds, on the other hand, some pains are taken to obtain the special quality of heat-resistance, and a low-phosphorus iron is always used for this purpose.

There are no tests for heat-resistance and chemical-resistance of cast iron in common use. For heat-resistance it is a very difficult matter to devise any single test which will answer for all classes of castings, since the effects of heat are manifested in several different ways. Chemical analysis may be specified with advantage in some cases, since the melting point of cast iron depends chiefly on this factor. Resistance to the action of chemicals can be tested directly without much difficulty in a manner similar to the accelerated corrosion test used on steel. There is, however, great need for the standardization of all conditions under which such tests are made, so that comparable results may be obtained.

Chilled car wheels form one of the most interesting applications of cast iron in American practice. The service conditions for these wheels are very severe. The load on each wheel often amounts to between 10,000 and 20,000 pounds. They are constantly subjected to heavy blows due to pounding at rail joints. The friction of the brake-shoes induces severe heat strains in the tread. Finally, the users of these wheels demand that they have a high resistance to wear. Owing to the nature of their service any failure is apt to be attended with very serious results, and hence great pains must be taken to insure a uniformly high quality of product.

The results desired are produced by the use of both special materials and special methods of casting. Formerly, charcoal iron was used exclusively for this class of work, but now coke iron enters largely into the mixture. The problem of a high-grade mixture has been much complicated by the necessity of remelting the old wheels, with their usual high content of sulphur. A partial corrective for the excessive amount of scrap which it is often necessary to use is found in the addition of ferro-manganese, and there have also been obtained some encouraging results through the use of ferro-titanium.

Methods of Casting Wheels

The special methods of casting consist in the use of a circular chill in that part of the mold forming the tread of the wheel. This method has been frequently described and needs no discussion. With the proper percentage of silicon this results in the tread being chilled to a depth of about ¾ inch, back of which is tough gray iron. The chilled tread is, of course, intensely hard and exceedingly resistant to wear, while the wheel as a whole is very tough and has proven eminently satisfactory in service. Steel wheels, long used on passenger cars, have recently been substituted on freight cars of very high capacity. They are, however, much more expensive and in some cases have not proven entirely satisfactory as to wear, so that there is every indication that the cast iron car wheel will hold its own for a long time to come.

The specifications and tests required for car wheels have been so often published and are so readily accessible that they need not be repeated at length. Briefly summarized the tests are carried out on a certain number of the castings themselves, and consist chiefly of a drop test to measure the resistance to shock and blows, a heat test made by pouring molten iron around the tread of the wheel, to measure the resistance to heat strains, and measurements to verify dimensions. It would appear that a hardness test on the chill might advantageously be added, in view of the known variation in the hardness of chilled iron. A test for wearing quality would be better still, but no satisfactory test of this sort is in sight.

Chilled Rolls for Rolling Mills

Cast iron rolls still hold their own in sheet mill and some other classes of finishing work, although cast iron has been quite generally displaced by steel for the heavier service. In this case the service conditions are not unlike those to which car wheels are subjected, but they are even more severe as to heat strains. Moreover, owing to the great thickness of the castings, the initial shrinkage strains are very great. The use of the very best grades of charcoal iron, together with air furnace melting, is generally recognized as necesary for the successful manufacture of chilled rolls, chiefly on account of the difficulty with cracking due to heat strains. It is reported that the use of vanadium in chilled rolls is adding considerably to their wearing qualities.

For this class of castings there are no satisfactory tests in sight. It is inconceivable that any tests could be of value which are not made on the roll itself, and, while a difficult proposition it is possible that in time a set of tests similar to those used on car wheels may be devised.

Brakeshoes may serve as an example of the many smaller specialties which are made of cast iron. The requirements here are long life, with this limitation: That the hardness of the brake-shoe must be less than that of the wheel so that the wear will not be on the wheel. A close grain structure is advisable, and in some cases at least is

being obtained by the use of steel scrap in the cupola mixture.

For brakeshoes a wearing test used in connection with hardness limits would best define their quality. No satisfactory method of testing resistance to wear is in sight, but it would seem that specifications for hardness alone could be advantageously used pending the development of such a test.

In point of tonnage, pipes are probably the most important castings made in this country. Cast iron is a particularly suitable material for pipes which are to be placed undergound, on account of its relative resistance to corrosion as compared with steel and other commercially available materials. Competition is keen in this line, so that low-priced iron is necessary. Within the limitations set by price, close grain and strength are desirable, while hardness must be kept within such limits as will permit of a small amount of machine work.

In regard to the properties of the metal, none of the present specifications for cast iron pipe lays stress on anything other than strength as determined on a separately cast test bar. A test for bursting strength and freedom from leakage made directly on the pipe would, of course, be a more accurate index of utility, but is probably too cumbersome for practical use. The transverse strength determination is probably as satisfactory as any simple test could be, but might with advantage be supplemented by specifying hardness limits.

Stoves and Furnace Work

Malleable cast iron and steel have been tried for stoves, but while they have perhaps a place, gray cast iron has proved more satisfactory and has steadfastly held its own. The service requirements here are resistance to the action of heat, resistance to warping, and a certain degree of strength. However, as these castings are very thin and are frequently highly ornamented, a very fluid iron is essential, and in practice the service requirements are deliberately ignored to facilitate manufacture. Resistance to heat requires low phosphorus, and resistance to permanent expansion, which causes warping, demands low silicon, but both phosphorus and silicon are invariably carried high in this class of work, to increase fluidity and make it easier to produce perfect castings. However, the product of our stove foundries is fairly satisfactory in service, and in appearance and finish has reached a high degree of perfection.

Specifications for stove and furnace castings should include tests for strength, hardness, since many parts have to be drilled, and resistance to heat. There is no trouble in regard to the first two tests, but, as previously stated, no good method has yet been devised for gaging heat-resistant qualities. Specification of chemical analysis can be used with advantage, but cannot be regarded as a really satisfactory substitute for the much-needed direct test for heat-resistance.

Commercial Tendencies in Malleable Practice*

By Richard Moldenke

AS IS WELL known, the production of malleable castings is carried out in America almost entirely with a view of obtaining the black-heart variety, while in Europe the white, steely fracture is the rule. The latter material may be readily machined and finished with little loss of strength, while the black-heart suffers seriously if the skin of the casting is removed. The differences lie primarily in the heat treatment given the two varieties of malleable castings, in the percentages of phosphorus and sulphur used, and finally in their subsequent uses.

The question of strength is not always a serious one in malleable casting work, so long as a casting is intended to be finished as part of a machine tool, or where the labor thus expended forms the principal item. Something a little better than cast iron is wanted, and the malleable casting machines easier than steel. Where, however, no labor whatever is intended to be expended upon the malleable casting, as is practically always the case with the black-heart American variety, there is a natural tendency toward making the least weight do the work.

Were this commercial consideration always accompanied with the proper understanding of the characteristics of the material involved, there would be no harm done. But where the consumer forces the manufacturer to take chances his better judgment would not sanction, then it becomes a serious matter. In the first case this continual demand for a better grade of material is a good thing for the development of an industry, since stricter specifications are made and methods of production are improved; in short, a pound of iron is made to go further in the service of man than it could before. On the other hand, the following may be said to apply: That in the entire range of the casting industry there is a present tendency toward running up the more striking characteristics of a material to a point of excellence at the expense of other, but none the less valuable properties. For instance, instead of making use of the ordinary malleable casting, as readily made from good irons under standard conditions, a grade of cast iron made with the plentiful addition of steel to the mixture, and advertised as semi-steel, is substituted on account of its lower cost. Again, instead of using the steel casting direct, where a high tensile strength is desired, a very-low-total-carbon malleable casting is made to do because it is cheaper.

The result of this short-sighted policy is the production of a series of supposedly high-grade materials which, in reality, are very unreliable. The principal sufferer is the consumer, who does not make any specifications, but gets the bulk of the metal that has to be made to satisfy the one who does. The latter, who may need only a limited quantity, asks for the almost impossible, and the product is probably entirely unsuited for general work.

Attention is directed to the above tendency in America at this time, because the exportation of black-heart malleable castings is beginning to be a factor in international trade. With a present American production of some 800,000 tons of these castings, and a capacity of over a million tons annually, there is bound to be some investigation on the part of consumers in other countries relative to the merits of the material in question. This in turn compels the

*Presented at the International Congress for Testing Materials.

producers of those countries to take notice and will naturally affect their practice.

So that the matter may be better understood, a few necessary details of production are given: In regular malleable melting practice, both in Europe and America, a limited amount of steel scrap is added to improve the material. This effects an initial reduction in the total carbon with a consequent increase in the tensile strength of the finished castings. With the very best of irons, short heats, first-class annealing conditions, and in fact the carrying-out of the processes which are calculated to give the best results, it is not possible to get a very high tensile strength without sacrificing some of the shock-resisting properties for which the malleable casting is justly famous. Thus, the ordinary blackheart product, as tested transversely by means of the 1-inch square test bar placed on supports 12 inches apart, should stand a load of 3,000 pounds applied at the center, and give a deflection of at least ½ inch, and in exceptionally good material the deflection may run even beyond 2½ inches. The tensile strength of such test bars will not run much over 42,000 pounds per square inch. It is quite possible, by a heavy initial reduction in the total carbon through steel scrap additions, to obtain tensile strengths of above 58,000 pounds per square inch, and when extreme care has been exercised in the melting and annealing processes to keep oxidation of the metal down to a minimum, the deflection will still be good. The chances are, however, so very much against this, even in the highest type establishments, that whoever insists upon this high-grade material and bases the calculation of his structures involving risk of life upon them makes a serious mistake. He had much better specify the steel casting in the first place.

As a mere item to show the delicacy of the manufacturing process there may be mentioned the fact, well known to the producer, but perhaps not at all to the consumer, that with composition and manufacturing processes identical up to this point, castings taken from saggers dumped on Monday morning—the one day when the annealing ovens are discharged cold—are much softer, bend and twist better, and are in every way more desirable as malleable castings, than those obtained the other days of the week. Yet the tensile strength of such castings is considerably below those dumped hot.

The malleable casting differs from all others in that any attempt to correct the oxidation of the metal in a heat before pouring so increases the expense that it cannot compete with cast steel. With the addition of much scrap steel to a charge, with the personal equation of the probable low type of melter, and with the probable variations in the annealing temperatures, an attempt to work for very high tensile strengths is not followed by reliable results. The chance of oxidizing the iron, in addition to the silicon and manganese, is such that a more or less open crystalline structure results, with consequent penetration of further oxygen during the annealing process, weakening the casting. This may be readily seen from the effect of changing to coke irons from the charcoal varieties. Charcoal irons, with their high total carbon and comparative freedom from oxidation as blown in the furnace when compared with the coke irons, gave the foundryman a chance to obtain good castings in spite of slight unavoidable variations in his practice. In American practice, at least, the change to coke irons has compelled the raising of the silicon specified in pig irons, in order to avoid this chance of initial oxidation as much as possible.

Until we have better melting methods, possibly when the electric furnace has been sufficiently developed along lines of economical production and until we can obviate or cheaply correct any undue oxidation of the molten metal before it is cast, it would be wise to lay more particular stress upon the development of the malleable casting commercially along lines of greater softness rather than high strength. Where the latter is essential the steel casting is certain to replace it sooner or later. On the other hand, with the specifications so shaped that the resilience of the material is made prominent for ultimate development, the merits of this peculiar product of the casting industry will be brought out and the material kept in its proper sphere of usefulness.

A NEAT AND WELL-ARRANGED FOUNDRY STOCK YARD

Well-Arranged Storage Bins

The accompanying illustration shows a neat and well-arranged stock yard at the foundry of the Oliver Iron Mining Co., Hibbing, Minn. The bins are made by setting 6-foot posts in the ground, the partitions consisting of 10-inch rough planks. A track is laid along the front of the bins so that material may be loaded or unloaded easily and quickly. Each bin is plainly labeled and the various kinds of scrap are separated. There are separate bins for wheels, pipe, short scrap, long scrap, rails, cast iron and pig iron. With the various kinds of scrap and pig iron carefully separated in this manner, it is very easy to make up the cupola charges and mistakes are of rare occurrence.

Book Review

Hendricks' Commercial Register; 1,574 pages; published by the S. E. Hendricks Co., 74 Lafayette street, New York, and furnished by THE FOUNDRY for $10, postpaid.

The twenty-first annual revised edition of Hendricks' Commercial Register of the United States, for buyers and sellers, recently issued, contains a total of more than 50,000 classifications, each representing the manufacturers or dealers of some machine tool, specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mining and kindred industries. This directory contains 1,574 pages, an increase of 155 pages over the twentieth edition. While the twentieth edition required 108 pages to index its contents, the twenty-first edition requires 122 pages. The classifications are so made that the book can be used either for purchasing or mailing purposes.

A Pattern-Drawing Device

A device for drawing patterns from the sand has been invented by Henry Tscherning, Freeport, Ill., the details of which are shown in the accompanying illustrations. Referring to Figs. 1 and 2, which show a plan and elevation of the device, it will be noted that the machine consists of a three-legged cast iron frame resting on the drag and supporting a cross bar which carries the mechanism for drawing the pattern. This

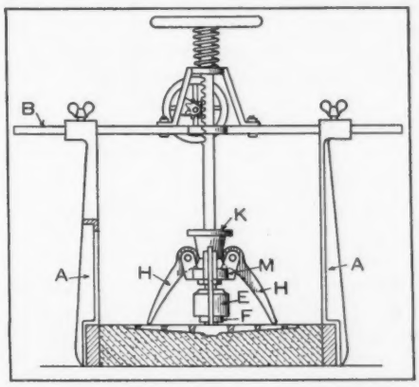

FIG. 1—ELEVATION OF PATTERN-DRAWING DEVICE

consists of a plunger-rod fitted with a rack and pinion at its upper end and carrying at its lower end a special rubber thimble to engage the pattern. There are also four spider legs to steady the pattern as it comes from the mold.

The lower ends of the three-legged frame, *A*, Fig. 1, are notched or shouldered so that they rest on the edges of the drag. The cross bar, *B*, which carries the drawing device, may be clamped securely to the legs by the thumb screws shown in Fig. 1. The mechanism can be adjusted to fit any drag, and the cross bar can be moved at will to bring the operating portion into any desired position with reference to the contents of the flask.

The bar, *B*, supports at the middle a yolk-shaped bracket, which is perforated in the center for the passage of the plunger-rod. The plunger-rod is provided with a handle at its upper end and also with a rack. A spring surrounds the upper end of the plunger-rod and presses upward with sufficient force to prevent its falling by gravity. The pinion, and hand-wheel connected with it, are mounted as shown in the illustration.

On the extreme lower end of the plunger is a block, *E*, Fig. 3, containing a piece of rubber, *F*, having a conical depression, *G*, which engages a similarly shaped projection upon the pattern. Above the pattern engaging mechanism, at the lower end of the plunger, is mounted a spider, *M*, provided with four radially projecting arms turned upward at their ends. The spider rotates on the plunger and can be locked in any desired position by a set screw. Pivoted fingers, *H*, are connected to the spider. These fingers each have enlarged circular heads which come in contact with the locking cone, *K*.

After the cope has been taken off the drag, it is sometimes difficult to draw the pattern, particularly if it has long projections running down into the mold. This mechanism is claimed to be specially suited to drawing deep, intricate patterns of this type.

In operating the device, the legs of the frame are adjusted to fit the drag and the cross-bar, *B*, Fig. 1, is then placed in such a position as to bring the plunger centrally over the pattern. The pattern engaging mechanism is then fitted to the pattern in the manner described, and the fingers, *H*, are arranged so as to contact with the pattern as illustrated in Fig. 1. These hold the pattern in a fixed angular position with reference to the plunger. When the fingers are properly placed, the locking cone is dropped and the plunger is elevated by means of the rack and pinion.

It is claimed that the device can be

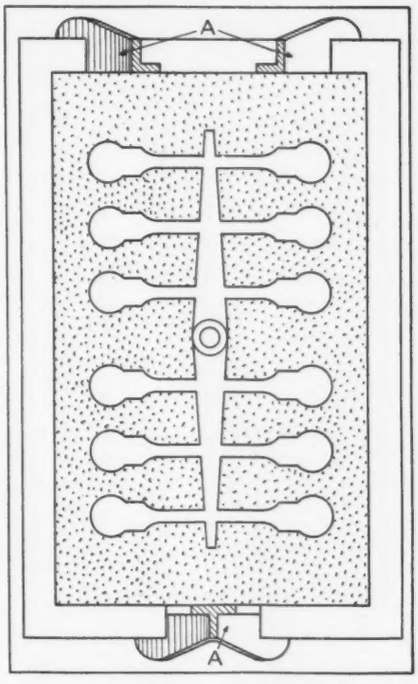

FIG. 2—PLAN OF FLASK WITH PATTERN-DRAWING DEVICE

adjusted quickly and used rapidly and that it is especially suitable for drawing duplicate patterns. Furthermore, the machine is designed so that the pattern is held in an absolutely fixed position and tilting and rocking are impossible. It is not necessary to rap the patterns.

Lifting-Out Hook for Crucible Furnaces

A very handy lifting-out hook for brass melting furnaces consists of a double hook that catches under each

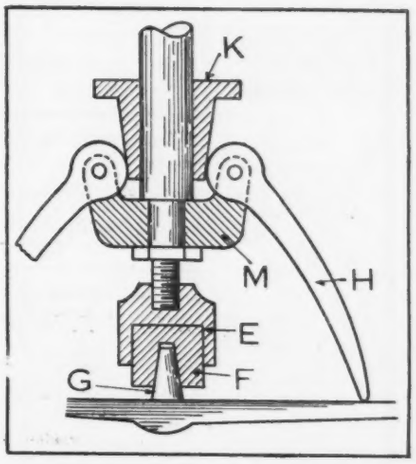

FIG. 3—DETAILS OF PATTERN ENGAGING MECHANISM

shoulder of the tongs, near where they clasp the inner edges of the crucible. This hook is made from a piece of ⅝-inch round iron, the length of which can be ascertained from measurements obtained by fitting the tongs on a cold pot. The hook is shaped like an inverted V, all three ends of which are bent over into hooks, the one on the apex of the V being on the opposite side to those on the straddled ends. In making the hook the bar of iron is heated in the middle and then bent to a V. The closed end is hammered together for a distance of about three inches from the bend, and is then turned over into a hook with an opening of 1½ inches at the bottom. This hook is engaged by the lifting-out bar, or it may also be used with a triplex block, provided a loose ring is slipped over the lifting chain of the block, and then over the handle of the tongs, so as to bind chain and tongs together, and prevent the pot from overturning. The straddled ends of the lifting-out hook are then each bent to a two-inch radius on the opposite side from the first hook. When in use the hooks catch under each jaw of the tongs near the inner sides of the pot, while the hook, at the apex, lies close to the handle, making an easily adjusted and substantial arrangement, that is difficult to unhook by accident.

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Trade Outlook

ASIDE from the difficulties that are being experienced in obtaining skilled molders and laborers, foundrymen generally are satisfied with prevailing operating and trade conditions. Disturbances are reported from a few centers where the men are contending for shorter hours and higher wages, and in many instances these demands are being granted to prevent interference with operations as the pressure for the early delivery of castings is unusually heavy at the present time. In no branch of the casting trade is a dearth of orders reported and some shops have been compelled to refuse desirable contracts owing to the fact that they are unable to meet the shipping requirements. Railroad car works are crowded to capacity and an unprecedented tonnage of malleable and steel castings is being purchased. Following the heavy buying of pig iron in August, the decline in activity in September was not entirely unexpected. However, this is not to be construed as an indication of weakness, as prices for metal for prompt shipment have been advanced steadily. No. 2, southern, for early shipment is now held at $12.50 to $13, Birmingham, and for delivery after the first of the year, $14 is asked. In other districts foundry grades of pig iron are quoted as follows: No. 2, $15.40 to $15.65, and malleable, $15.15 to $15.40, Pittsburgh; No. 2, northern, $16, and Lake Superior charcoal, $16.75, Chicago; No. 2, $15, Cleveland; No. 2, southern Ohio, $15.70 to $16.20, Cincinnati, and No. 2X, eastern Pennsylvania, $16.25 to $16.50, Philadelphia.

Founders' Week at Buffalo

THEORETICAL and practical instructions in foundry work will be combined at the annual meetings of the allied foundrymen's associations, which will be held in Buffalo during the week of Sept. 23. Every foundryman should arrange to attend and he should be accompanied by his shop executives who are certain to derive great benefits from the papers to be presented, the ensuing discussions and the exhibits of foundry equipment which, to a large extent, will be operated. Both the American Foundrymen's Association and the American Institute of Metals have arranged extensive programs and these societies will each hold three-day sessions. The symposium of papers on steel foundry practice will greatly interest those engaged in this line of work, while many live subjects will be considered at the meetings of the brass foundrymen. Approximately 100 manufacturers have arranged to make exhibits and the display of all kinds of foundry labor-saving devices promises to eclipse all previous efforts. No industry has undertaken educational work on so extensive a scale as that carried on annually for the benefit of the foundrymen of the United States and Canada. Every manufacturer operating a casting shop should insist upon the attendance of his superintendent and foreman, and if their services cannot be spared for the entire week, their presence in Buffalo for several days is certain to prove extremely beneficial. Many foundrymen operating large plants are arranging to send their entire shop executive forces and in many instances the necessary expenses of the men are being defrayed by the companies with which they are affiliated. The improvements which have been made in labor-saving molding devices during the year are particularly noteworthy.

Equipment for the Foundry and Pattern Shop

Roller-Ramming and Pattern-Drawing Molding Machine—A Cupola Blast Meter—The Manufacture of Steel Flasks—Foundry Handling Equipment

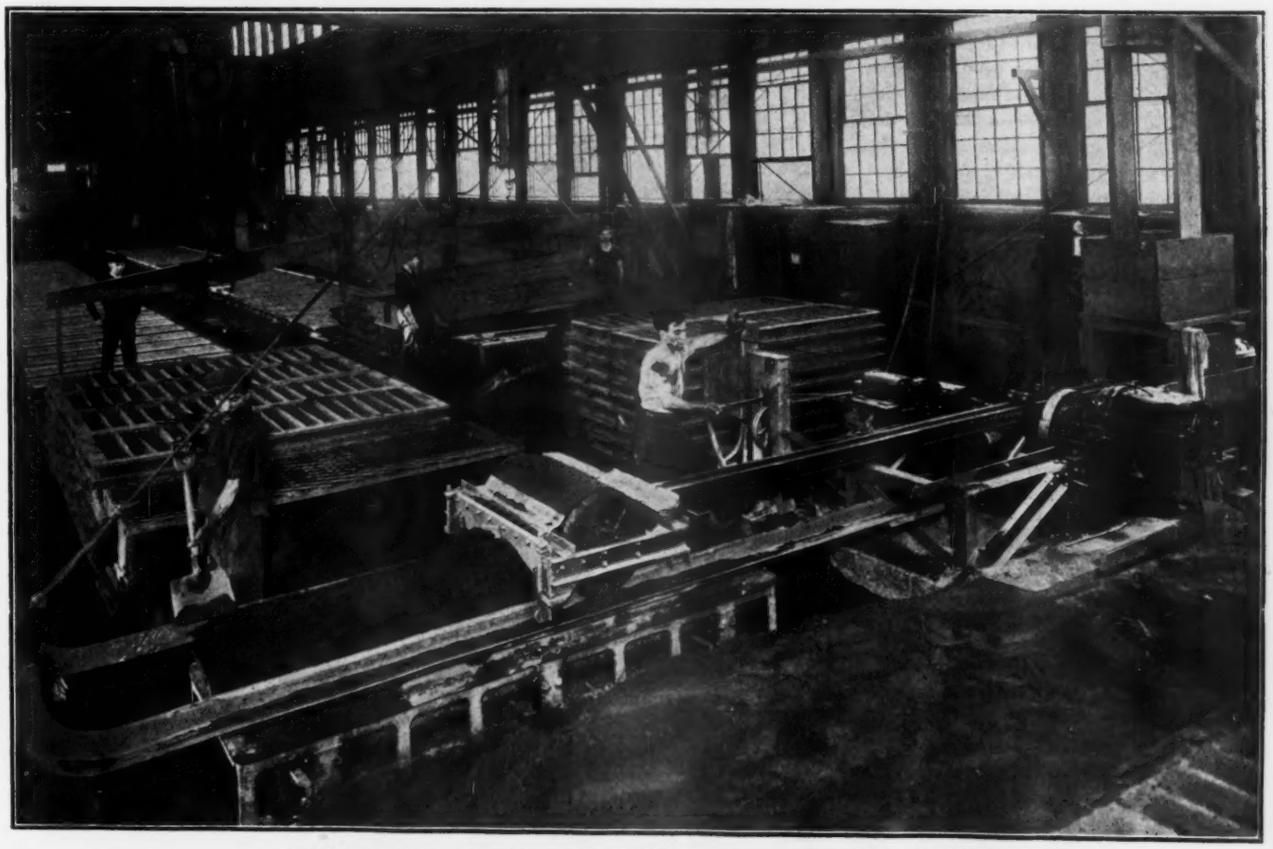
THE Snead Iron Works, Jersey City, N. J., is now building for the trade a molding device known as the MacDonald roller-ramming and pattern-drawing machine, which was developed for making library book stack castings and has been in use in this company's shop for several years. As shown in the accompanying illustration, the ramming device consists of a heavy steel frame supporting an electric motor and controller. The motor, through a train of gears, drives a long rack with a forked end, in which is trunnioned a heavy cast iron roller, grooved at the ends to fit over angle iron tracks made in two sections. The fixed portion of these tracks is part of the steel frame and the movable part is hinged so that it can be placed in position on top of a flask while the latter is being rammed. The pattern is mounted on a special draw-plate machine, operated by a hand wheel and worm, which lowers the plate by means of compound toggles, thereby insuring a smooth and uniform draw.

In operation, the flask is placed over the pattern, parting and facing sand are applied and the angle tracks are lowered into position. The flask is then filled with sand and the roller is operated. As it moves forward, it is preceded by a strike-off, so arranged that it levels the sand to a uniform height regardless of the position of the roller. At the end of its stroke, the roller reverses automatically and returns to its first position. Two round trips of the roller are usually sufficient to ram the flask. The tracks then are removed, the flask is struck-off, the pattern is drawn and the finished drag is set on the floor, ready to receive the cope, which is made in a similar manner. Both cope and drag flasks are barred and no bottom boards are employed.

Three of these machines now are in operation in the Snead foundry and on each of them two laborers make from 30 to 35 molds per day, each 8 feet long, 30 inches wide, with 6-inch cope and drag.

An important accessory is a heavy wooden box with a top consisting of coarse mesh wire, one side of the box being open, while holes are provided at the ends to engage the hooks on the yoke used to handle the flasks. The flasks are shaken-out into this box before they are placed on the machine, the screen breaking up the lumps of sand. The box then is lifted and its contents are dumped into the flask about to be rammed, thereby eliminating the cutting of the sand.

The sand is uniformly rammed and the mold is without soft spots underneath the bars or along the sides. The castings are uniform in weight and are remarkably free from blowholes, strains and other defects. This molding device is especially adapted to the production of long, shallow work, such as loom ladders and rails and other parts of textile machinery, soil pipe, stair stringers and risers,



ROLLER-RAMMING AND PATTERN-DRAWING MOLDING MACHINE

radiators, etc. In the accompanying illustration, the roller is shown running from a flask with a strike-off leveling the sand in front of the roller. In the background is shown another machine, together with the molds made on this device. In this case, a Pridmore drop-plate machine is used to draw the pattern.

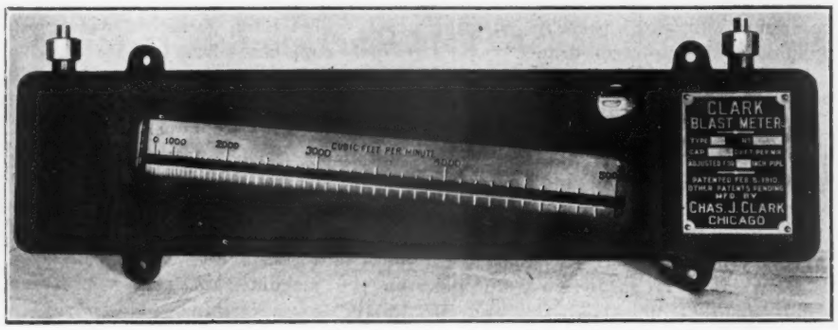


FIG. 1—GAGE FOR CLARK BLAST METER

The Clark Cupola Blast Meter

In the successful operation of a cupola it is essential to ascertain the volume of air that is passing through the tuyeres, as the pressure alone is not indicative of the amount of air entering the furnace. Gages frequently show the highest pressure when the smallest amount of air is entering the cupola. An increase of blower speed and the stopping-up of the tuyeres both will produce a high pressure in the supply pipe. In the case of the first the air supply is increased and in the second it is decreased. The speed of melting, the amount of oxidation and the temperature of the melted metal can be controlled or varied by regulating the blast volume.

The Clark blast meter, shown in the accompanying illustrations, consists of a gage which may be located at any convenient point near the cupola, and a pressure tube which is tapped into the blast pipe. The two parts are connected by flexible seamless tubing. The blast meter is illustrated in Fig. 1, the pressure tube in Fig. 2 and Fig. 3 is a view of an installation of this device. The gage is enclosed in an iron case with a glass panel in front, recessed for safety and better illumination. A glass tube and a graduated scale are back of this panel. The height of the liquid in this tube shows directly the number of cubic feet of air per minute passing to the cupola. The scale is made of German silver and can be read easily even in a poor light. The liquid in the glass tube requires no replenishing, as it neither evaporates nor freezes. Near the upper part of the gage is a spirit level to insure proper installation. The gage of the blast meter usually is attached to the wall at the side of the melter's platform where it may be closely watched throughout the course of each heat. As the air in some cases carries a considerable amount of dust, a valve is arranged to close the openings of the pressure tube. When a reading of the gage is to be made, the small lever near the gage, Fig. 3, is pulled down. This opens the valve and places the instrument in operation. If the blower intake insures a supply of clean, fresh air, the pressure tube valve may be kept open, permitting the gage to register continuously. All connections are brazed so that the pressure tube will withstand a red heat if necessary.

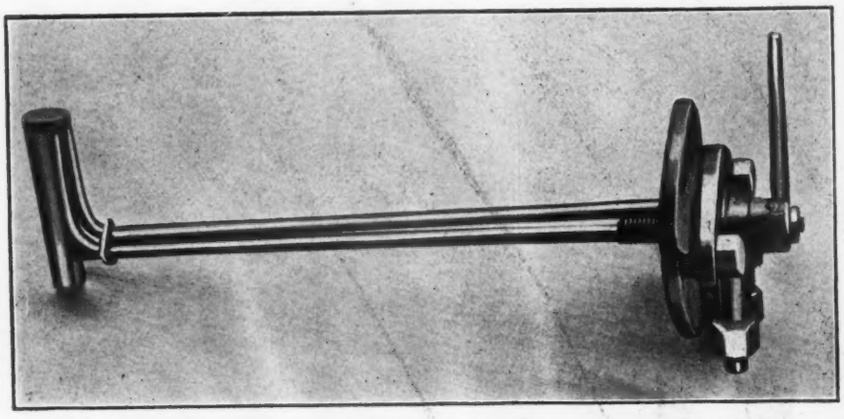


FIG. 2—THE PRESSURE TUBE WHICH IS INSERTED IN THE BLAST PIPE

Copper Castings Free from Blow-Holes

Dr. E. Weintraub, of the General Electric Co., Schenectady, N. Y., recently has obtained a patent on his method of producing copper castings free from cavities. The process essentially consists of adding to molten copper a small quantity of boron, varying from 1-30 to 1-10 of 1 per cent. This may be added in the form of a boron compound, such as a sub-

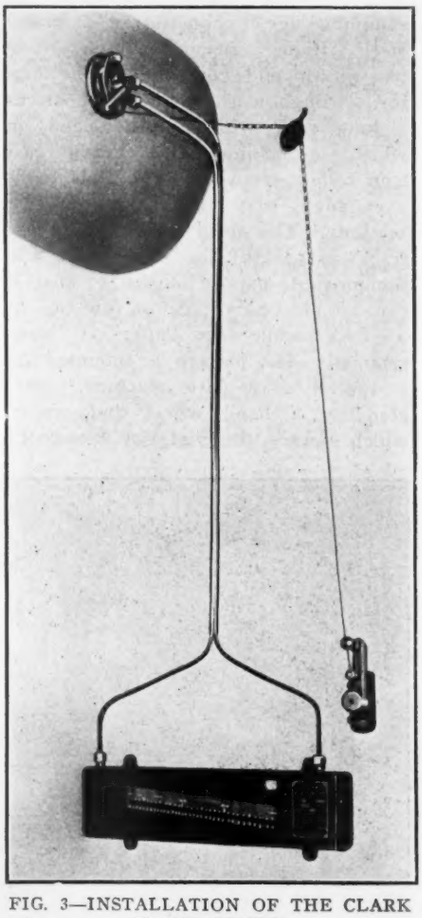


FIG. 3—INSTALLATION OF THE CLARK BLAST METER

oxide or carbide. Copper castings made from copper treated in this way are free from blow-holes and show an electric conductivity from 95 to 98 per cent. When applying this method of melting, the boron material is placed in the bottom of a crucible and is mixed with pure charcoal, after which it is covered with the copper to be treated. The copper is not injured by an excess of boron, as it does not combine with the metal, but either oxidizes and collects as a slag or remains mechanically mixed in the copper.

FIG. 1—CUTTING AND BENDING DEPARTMENT

FIG. 2—A VIEW OF THE DRILLING DEPARTMENT

The Manufacture of Steel Flasks

Steel is rapidly replacing wood in the construction of foundry flasks and to meet the increasing requirements for this steel foundry equipment, the Sterling Wheelbarrow Co., West Allis, Wis., about four years ago engaged in the manufacture of steel flasks made of a special rolled section. Up to the present time, approximately 50,000 flasks have been made and a large department is devoted exclusively to this line of work. The rolled shape used in the construction of these flasks is a reinforced channel section made in seven widths, from 2½ to 8 inches. These permit of the manufacture of a wide variety of sizes, from 12 x 12 inches with a 2½-inch cope and drag to 24 x 60 inches, with an 8-inch cope and drag. More than 2,000 different sizes are made which are graduated in inches and the sizes in fractions of inches enormously increase this total.

The equipment of the department devoted to this work is unusually complete, as shown in the accompanying illustrations. Fig. 1 illustrates the machinery utilized for cutting and bending the rolled sections which are received in 20-foot lengths. In addition to the two large presses shown in the foreground, the necessary dies for cutting and bending the several different widths of material complete the equipment of this department. After the material has been cut and bent, it is laid out and punched for the innumerable pinholders and reinforcements necessary to meet the requirements of each individual order. The trimmings usually vary, as hardly any two foundries follow the same practice in flask design.

In Fig. 2 is illustrated the drilling department in which the holes in the flasks and trimmings are drilled. In each flask and its trimmings there are never less than 64 holes and as high as 260 holes are required on flasks of certain styles. Two power-operated riveting machines which drive an average of 2,000 rivets an hour are illustrated in Fig. 3. By these machines the trimmings and reinforcements are attached. The initial finishing operation consists of squaring and truing the flasks. The final finishing operation includes drilling pin holes and attaching pins to the flasks. A view of this department is illustrated in Fig. 4. Several different sizes of pins and various clearances are required to meet the many demands of the foundry trade. The output of the plant is 100 flasks per day.

Frank Wright, Chicago, has been appointed general works manager of the Ohio Steel Foundries Co., Lima, O.

Chas. S. Bird and Samuel C. Barnes have become associated with the engineering department of the Thos. W. Pangborn Co., Hagerstown, Md. Mr. Bird has been appointed assistant mechanical engineer and Mr. Barnes becomes a member of the general engineering staff. Mr. Bird for several years was associated with the American Steel Foundries, originally in the capacity of engineer and later as assistant manager of the Alliance, O., plant. Mr. Barnes for about 10 years was identified with the engineering department of the Frick Co., Waynesboro, Pa.

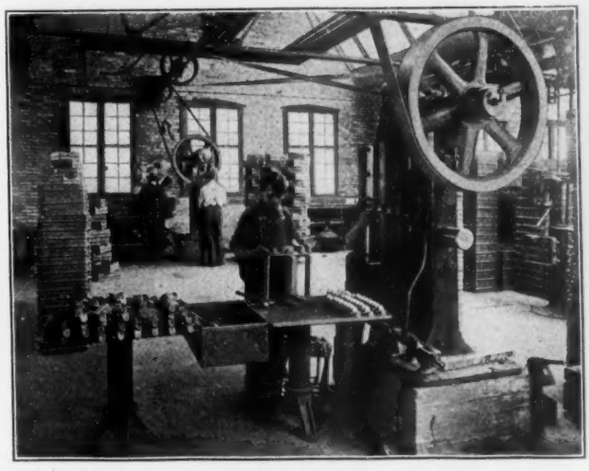


FIG. 3—THE RIVETING DEPARTMENT

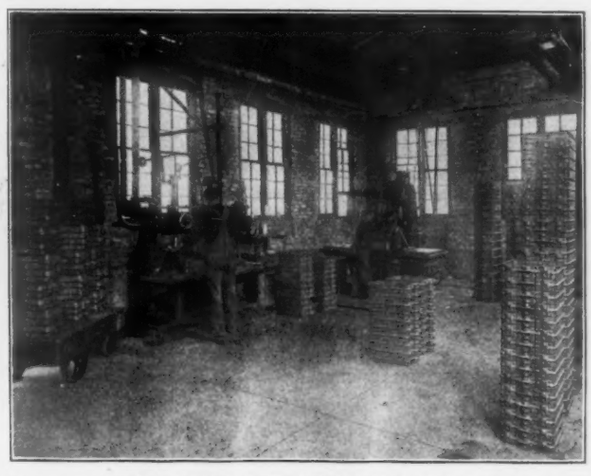
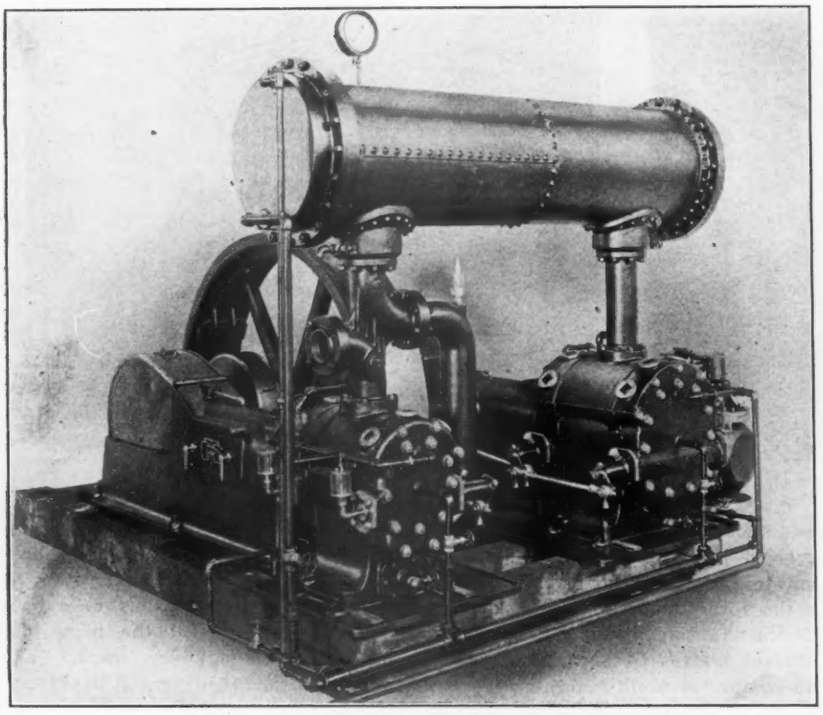


FIG. 4—DEPARTMENT FOR DRILLING PIN HOLES AND ATTACHING PINS



ENCLOSED TYPE, BELT-DRIVEN, AIR COMPRESSOR

New Type of Air Compressor

The accompanying illustration shows the smallest size of a new line of enclosed type, self-oiling, belt-driven air compressors now manufactured by the Chicago Pneumatic Tool Co., Chicago. This machine has two-stage air cylinders, 16 and 10 inches in diameter, with a 12-inch stroke, and at its rated speed of 210 revolutions per minute, has a displacement of 576 cubic feet of air per minute. Mechanical inlet air valves of the semi-rotary Corliss type are used, actuated by eccentrics on the compressor shaft. The discharge valves are of the air-cushioned, poppet type, and are placed radially in the heads. Considering that the valves are interchangeable and accessible for adjustment and renewal, it is claimed that this arrangement insures high volumetric efficiency and the elimination of valve troubles. The heads and cylinder walls are completely water-jacketed and are arranged with independent water supplies, which permit the use of solid gaskets between the heads and cylinders.

The frames are of the full tangye type, with bored crosshead guides which completely enclose the crosshead bearings. The cranks and eccentrics are enclosed in a substantial planished iron casing which permits flood lubrication of the main bearings, crosshead and moving parts, through the use of an automatic gravity system. The inlet valves and pistons are lubricated with large, glass, sight-feed lubricators on their caps, and all valve gear bearings have extra large compression grease cups. The intercooler is of the steel shell, marine condenser type, mounted overhead, and is provided with composition tubes, baffle plates and separator drip pockets. The air cylinders are bolted directly to the tangye frames and extend down to large sole plates, surrounded by drip guards. The balanced disc cranks are pressed and keyed to the shaft and the driving pulley is split-keyed to the shaft and is machined true on its face and edges. The pulley is of unusually heavy design to give the effect of a flywheel. Control is effected through an improved throttling intake controller operated by receiver pressure; it is capable of close regulation, making it possible to adjust the load to meet the air demands, thereby reducing power consumption. This type of compressor is furnished in capacities up to 4,000 cubic feet of air per minute, and equivalent sizes and capacities can be furnished with a short belt drive or with a motor drive in which the motor is mounted directly on the compressor shaft.

Economical Foundry Handling Equipment

An esculator is shown in Fig. 1, which has been installed by the Chain Belt Co., Milwaukee, at the plant of the Northwestern Malleable Iron Co., in that city, for the purpose of loading castings. The esculator consists of a double strand of bolted roller chain belt with 1½-inch flights attached. The flights are 3 feet wide and the conveyor travels at the rate of 75 feet per minute, the center to center distance between the head and foot sprockets being approximately 25 feet. The height of lift is 4 feet. At

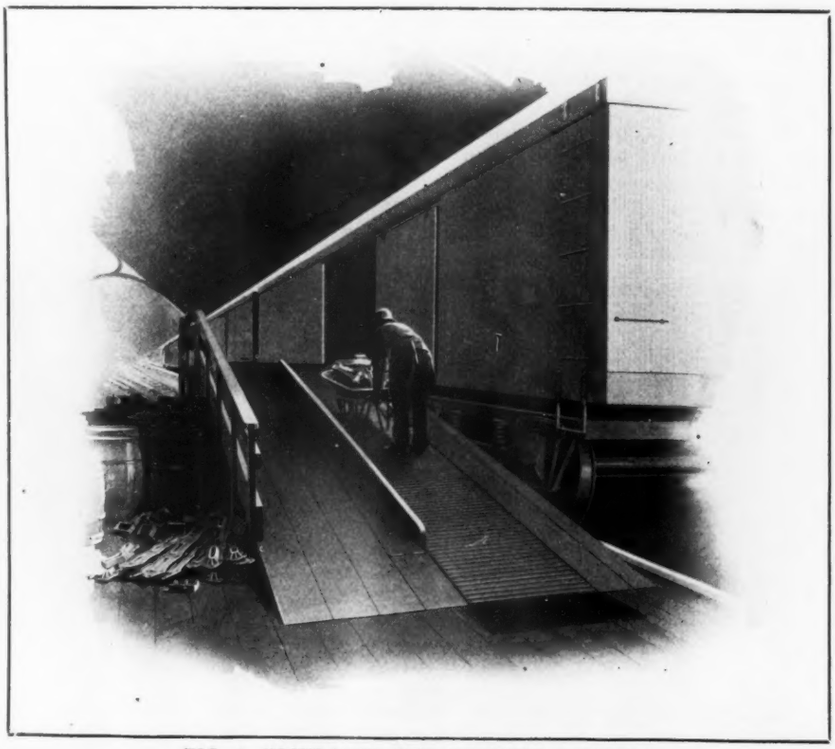


FIG. 1—ESCULATOR FOR LOADING CASTINGS

the speed noted, the conveyor will deliver a maximum of about 400 wheelbarrow loads of castings per hour. It is driven by a 3-horsepower, 110-volt, direct current motor operating at 1,025 revolutions per minute. The reduction in speed is taken care of by means of a train of spur gears. This device has been found very useful in loading small castings into box cars. It is much more rapid than direct hand-loading, less men are necessary and consequently the machine is said to effect a considerable saving. The speed with which cars can be loaded also results occasionally in saving demurrage.

Fig. 2 illustrates a sand elevator

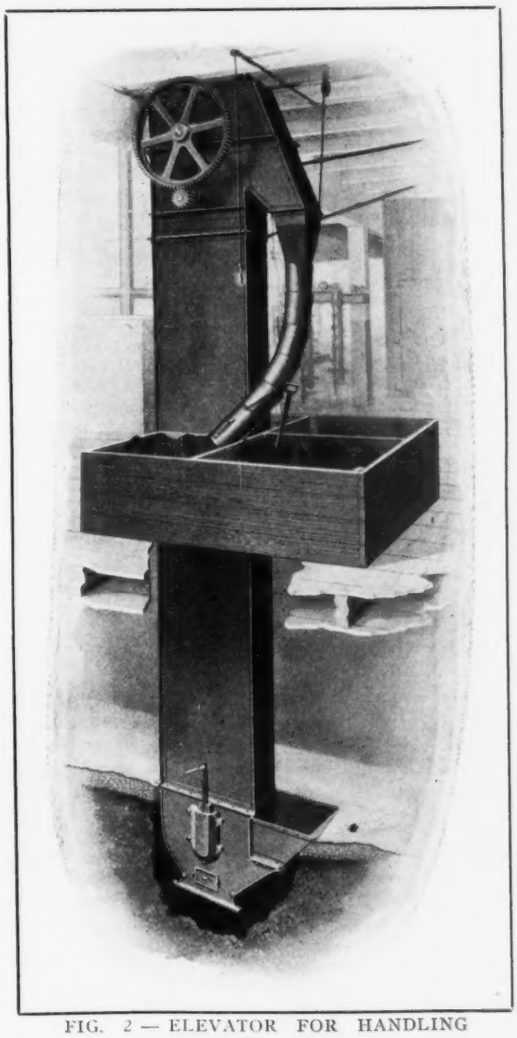


FIG. 2 — ELEVATOR FOR HANDLING CORE SAND

which has been installed by the Chain Belt Co. in the same plant. This machine is used for hoisting core sand from the bins on the ground floor to the core room above. It is 34 feet in length between centers, and the malleable iron elevator buckets are mounted on a single strand of chain belt. The elevator travels at a speed of 200 feet per minute, and at this speed has a capacity of 25 tons of core sand per hour. It is driven by a 3-horsepower, 110-volt, direct current motor, which is connected to the elevator by a belt to a countershaft and a train of gears. The elevator hoists the sand to the ceiling of the core room. From this point it is discharged through the flexible spout shown in Fig. 2, which may be adjusted to drop sand into any one of several compartments.

Crucible Cover

In the accompanying illustration is shown a crucible cover designed for brass foundry use, manufactured by the Modern Equipment Co., 608 Elmwood avenue, Providence, R. I. The cover is placed over the crucible when the pot is removed from the furnace and after the charcoal or other covering has been skimmed off. The cover is made of iron and is provided with a metal strap designed to hold the cover on the crucible while pouring. In addition, it is provided with a plumbago skimming lip. When pouring crucibles without covers a large volume of smoke and gas usually arises from the metal, which is not only injurious, but to some extent interferes with proper pouring. It is also necessary, when pouring by the old method, to skim back the flux and slag on the metal. By the use of this cover this operation is entirely eliminated. When the cover is placed on the pot the metal is skimmed while being poured and, in addition, smoke and gas do not arise from the metal and oxidation is prevented. Casting losses are greatly reduced as the brass sections will be found to be free from defects frequently arising from oxidized metal.

CRUCIBLE COVER PROVIDED WITH A PLUMBAGO SKIMMING LIP

A New Aluminum Solder

A patent for an aluminum solder, granted to Chas. R. Erkens, has been assigned to the Simplex Aluminum Solder Co., New York City. It is claimed that the solder can be used without first pre-heating the parts to be joined. The composition consists of 60 parts of tin, 15 of zinc, 10 of lead and 5 each of antimony, bismuth and chromium. After melting and mixing these metals, the alloy is cleansed while molten by adding 35 grams of salicylic acid and 19 grams of calcium to each 5 pounds of the alloy. As a suitable binding agent for impurities which form a slag to be skimmed from the alloy, 17.72 grams of sulphur are added. About 5 per cent of the oxidizing and cleansing agents will be retained in the alloy and will serve to take the place of the flux ordinarily used in solder-

Core and Annealing Ovens

"Ovens for Baking Cores, Mold Drying and Annealing Castings," was the subject of a paper read by A. W. Moyer, of the Rockwell Furnace Co., at the meeting of the Pittsburg Foundrymen's Association held at the Fort Pitt hotel, Pittsburgh, Monday, Sept. 9. The lecture was illustrated by lantern slides. W. O. Renkin, supervising engineer of the Tata Iron Works, Sakchi, Bengal, India, briefly described the construction of this plant and illustrated his talk with a number of very interesting photographs.

"Publicity Engineering," is the title of a 23-page booklet issued by Walter B. Snow, 170 Summer street, Boston. The term "publicity engineering" is defined as a combination of practical engineering knowledge and advertising experience for the creation of productive publicity regarding technical matters. The booklet is devoted to Mr. Snow's organization and the service which he renders to his clients.

Max Breitenbower has been appointed foreman of the Standard Chemical Co.'s brass foundry, Canonsburg, Pa.

General Industrial Notes

The John C. Kupferle Foundry Co., St. Louis, was recently extensively damaged by fire.

The plant of the Racine Steel Casting Co., Racine, Wis., was recently damaged by fire to the extent of about $8,000.

The Sioux City Foundry & Mfg. Co., Sioux City, Ia., has been succeeded by the New Foundry & Mfg. Co.

The Ecothermal Stove Co., Warren, O., has been incorporated with a capital of $150,000 to engage in the manufacture of stoves.

The Iron City Foundry Co., Lebanon, Pa., which makes a specialty of manufacturing sash weights, is now located in its new plant.

The Parks-Treanary-Houchin Foundry Co., Atlanta, Ga., has been incorporated with $6,000 capital by W. W. White, W. F. Treanary and others.

The National Radiator Co., Johnstown, Pa., has added a brick foundry extension, 260 x 300 feet, to its plant at Trenton, N. J. This plant is now running 30 floors on radiators.

The General Malleable Co., Warren, O., has been incorporated with a capital stock of $20,000 by E. T. Ward, O. R. Grimmesey, Geo. T. Fillius, S. B. Kissler and J. G. Gates.

The John Knapp & Sons Foundry Co., Akron, O., has erected a new plant of brick and steel construction, 60 x 80 feet. The daily output approximates 8 tons of gray iron castings.

The Turner & Seymour Mfg. Co., Torrington, Conn., has completed several extensions to its plant, including a core room, 52 x 58 feet, and a three story building, 40 x 64 feet, will be used for general manufacturing purposes.

The Safety Mfg. Co., Elizabethtown, Pa., has been incorporated with a capital of $100,000 to engage in the manufacture of safety appliances, castings, etc. The incorporators are Edward H. Gish, Elizabethtown, Pa., John J. Kauffman, Millersville, Pa., Harvey E. Sherts, Lancaster, and A. B. Magee, Dover, Pa.

The Pennsylvania Railroad has practically concluded negotiations for the purchase of three blocks of land on the east side of Canal street, from Twelfth to Fifteenth streets, Chicago, which is now occupied by several of the large foundries of the Crane Co. and if the deal is concluded it will be necessary for the Crane Co. to remove its plants and it is understood that the new shops will be erected at some outlying point.

The new foundry built by Harvey M. Ream, Lebanon, Pa., recently was placed in operation. The company makes a specialty of sash weights and formerly operated a shop in another section of Lebanon, but was compelled to build a new plant owing to the big increase in the demand for its product. The foundry is 80 x 65 feet and is equipped with a 7-ton cupola. The stock room is 40 x 40 feet and adjoins the main foundry building, while the storage bins for coke, sand, etc., are 50 x 25 feet.

The stock of the Trenton Malleable Iron Co., Trenton, N. J., has been purchased by the following, who comprise the new board of directors: Dr. John H. Murray, president; Jas. B. Dayton, vice president; Frank J. Eppley, secretary and general manager; Arthur Smith, treasurer; Wm. S. Schulte, Arthur A. Schumann, Henry B. Lapp, L. B. Grover, R. C. Chamberlain and E. D. Bloor. The direct management of the affairs of the company will be under the supervision of Frank J. Eppley, one of the founders of this plant. Walter H. Burgess will continue as superintendent.

New Construction

The Noelke-Richards Iron Works, Indianapolis, will erect a new foundry.

S. A. Loose & Son, Hamburg, Pa., are erecting an addition to their foundry, 30 x 42 feet.

Th Canadian Lock & Novelty Co., New Westminster, B. C., will erect a foundry and finishing plant at Edmonds, B. C.

The South Fork Foundry Co., Johnstown, Pa., contemplates extensive improvements and will purchase considerable equipment.

M. L. Oberdorfer, Syracuse, N. Y., will shortly commence work on the erection of a one-story foundry building, 48 x 76 feet.

The Patterson Foundry & Machine Co., East Liverpool, O., contemplates the erection of extensive additions to its plant.

The Youngstown Foundry & Machine Co., Youngstown, O., will erect an addition to its foundry, 34 x 98 feet. A building now under erection will be used as a pattern shop.

The Quigley Foundry & Machine Co., Chicopee Falls, Mass., has awarded a contract to the McClintic-Marshall Construction Co., Pittsburgh, for the erection of a new plant.

The New Process Stove Co., one of the plants of the American Stove Co., will erect three new buildings on Perkins avenue, Cleveland. They will vary in height from one to three stories.

The foundry of the Belcher & Taylor Agricultural Tool Co., Chicopee Falls, Mass., was recently destroyed by fire. A new plant, 50 x 160 feet, is being erected to replace the casting department.

The National Sanitary Mfg. Co., Salem, O., has commenced the erection of an addition to its foundry, which will practically double the present capacity. Enameled iron sanitary ware is manufactured.

The Whitin Machine Works, Whitinsville, Mass., manufacturer of textile machinery, will erect an addition to its foundry, 100 x 500 feet. No equipment has yet been purchased for this new department.

The Mountain City Stove Mfg. Co., Chattanooga, Tenn., has purchased the equipment of the Queen Range Mfg. Co., of the same city. The Mountain City Co. contemplates the erection of a new plant for the manufacture of stoves and ranges.

Rapid progress is being made in the erection of the foundry of the J. I. Case Threshing Machine Co., Racine, Wis. This plant is being built at Lakeside, near Racine, and it is estimated that it will cost approximately $1,000,000.

The Nichols & Shepard Co., Battle Creek, Mich., manufacturer of agricultural machinery, will erect extensive additions to its plant, including a foundry, 205 x 230 feet, and a machine shop 125 x 160 feet. A large amount of foundry equipment will be purchased.

The General Electric Co., Schenectady, N. Y., will build several additions to its Lynn, Mass., plant, which include a foundry, 123 x 132 feet; an administration building, 52 x 213 feet, four stories high; a sub-office building, 52 x 62 feet, and a transfer building, 31 x 78 feet.

Wm. R. Thropp & Sons Co., Trenton, N. J., will erect a gray iron foundry, 80 x 160 feet, of steel construction. An 8 to 10-ton cupola will be installed in addition to 7-ton and 15-ton electric traveling cranes. The present foundry will be abandoned and will be replaced by an extension to the machine shop.

The Pioneer Tractor Mfg. Co., Winona, Minn., is building a plant at Calgary, Alberta, Canada, which will include a machine shop and foundry of brick and steel construction. The machine shop will be 100 x 600 feet and the foundry, 100 x 80 feet. An office building also will be built which will be 100 x 80 feet. Shipping facilities are provided by both the Canadian Northern and Canadian Pacific railroads.

The Walker Tire Chain Co., Toledo, O., recently incorporated with a capital of $150,000, will establish a plant in that city for the manufacture of a patented anti-skid automobile and truck chain. A complete plant, including a foundry, will be erected. The headquarters of the company are now at 645 Ohio building. The officers of the company are H. F. Rohrman, president; Hugh Williams, vice president; Maurice A. Carter, treasurer, and Chas. E. Newman, secretary.

Extensive additions will be made to the plant of the Superior Foundry Co., Cleveland. A new foundry will be built, 90 x 350 feet, which will be devoted exclusively to the manufacture of gray iron castings. A fireproof pattern storage building and machine shop, 60 x 131 feet, and three stories high, also will be built. A large amount of molding machine equipment will be purchased. The Forest City Engineering Co., Cleveland, prepared the plans for the plant.

Among the Brass Founders

The Crane-Hawley Co., Cincinnati, will erect a new plant for the manufacture of plumbers' brass goods.

The Muskegon Aluminum Foundry Co., Muskegon, Mich., has been incorporated with a capital of $10,000.

The Standard Brass Co., Detroit, is erecting a new plant at a cost of approximately $25,000, which will be 92 x 166 feet in size.

The General Aluminum & Brass Castings Co., Detroit, is erecting a new plant, 120 x 200 feet, for the manufacture of brass and aluminum castings.

The Sterling Brass Co., Cleveland, has erected a new plant at Forty-seventh street and St. Clair avenue, for the manufacture of plumbers' brass goods.

The American Manganese Bronze Co., Holmesburg Junction, Philadelphia, is contemplating the erection of a new foundry, which will be 50 x 120 feet.

The Premier Aluminum Foundry Co., Cleveland, has been incorporated with $10,000 capital to engage in the manufacture of aluminum castings. R. E. Hyde is secretary of the company.

The Keyless Lock Co., Indianapolis, is building a foundry, 100 x 110 feet, of brick, steel and glass construction, which will be devoted to the production of brass, bronze and aluminum castings. This new plant will practically double the company's output and when placed in operation the production of castings will average from 20,000 to 25,000 pounds daily.